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THE AMERICAN GAS LIGHT JOURNAL

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[OFFICIAL NOTICE.]

Central New York Gas Engineers Association.

OFFICE OF CENTRAL N. Y. GAS ENGINEERS' ASSOCIATION, Sept. 15th, 1882.

On account of the Meeting of the American Gas Light Association occurring upon the day set apart for the semi-annual meeting of the Central New York Gas Engineers Association, the members of the latter Association are earnestly requested to be present at the American Association meeting at Pittsburgh, where final arrangements for a session will be arranged.

CLEM. A. WHITE, *Secretary.* JOHN MCDOUGALL, *President.*

[OFFICIAL NOTICE.]

American Gas Light Association.

OFFICE AMERICAN GAS LIGHT ASSOCIATION, No. 142 CHAMBERS ST., N. Y.

The Tenth Annual Meeting of the Association will be held in the city of Pittsburgh, Pa., on the 18th, 19th and 20th days of October, commencing at ten o'clock, A.M.

Headquarters of the Association will be at the Monongahela House—terms, three dollars per day.

Members who intend to present papers at this meeting are requested to notify the Secretary of the titles of their articles, so that a programme may be arranged at as early a date as possible.

Parties desirous of becoming members can have blank applications sent to them by applying to the Secretary.

WM. HENRY WHITE, *Secretary.*

PROGRESS OF GAS AND ELECTRICITY.

As time goes on and the earlier excitements incident to the first introduction of so-called novelty and new discovery gradually subside, as the echo of the flourish of trumpets preceding the launching of the great schemes of modern times dies away behind the rolling hours of three or four short years, a lull in the excitement, a quiet hour for actual investigation of facts is granted, and even the public, who are ever ready to grasp at novelty, and somewhat impatient of the delay of careful investigation, become satisfied in time that there is a wide margin between the promises of enthusiastic "promoters," and the results obtainable under the ordinary working conditions of every-day practice.

About four years ago we published a report, made by the Editor of this JOURNAL after a most careful investigation of the subject of electric lighting, made under exceptionally favorable circumstances in Paris, where "the light of the future" was then brought forth under most favorable auspices. The opinions expressed in the report are truer to-day than when they were written, if we may be pardoned the expression, for they are most fully borne out by the experience of the years that have elapsed since 1878. At that time the Avenue de l'Opera, the Place du Theatre Francais, and the Place de l'Opera, were refulgent with the beautifully chameleonizing effect of the Jablochkoff electric candle. Its use continued for some three years thereafter, but the traveler or the citizen looks in vain to-day for the electric light in any of these places, but instead, if one cares to notice, is to be found the improved street lighting by gas.

We are fully aware that the conditions under which the streets of Paris are lighted are exceptional; but this does not in any way affect the reasons for the discontinuance of the electric street lighting. That resulted simply from the inability of the company to continue the service, without financial loss, at the prices which were at first submitted as ample for proper compensation. In fact the manager of the company is said to have stated that they could not afford to continue the advertisement at so great an expense. A similar result was reached in London in at least one case—that part of the city in the vicinity of the Mansion House, which was most superbly lighted (regardless of cost) by the Siemens system. After one year's trial it was found that the price obtained, which was several times that previously paid for gaslighting, was not sufficient to warrant those supplying the electric light in continuing the service without a large increase in compensation.

Dr. Siemens, himself an eminently practical as well as scientific man, expressed the idea, in a letter to a London paper, that while others might be able to afford to continue the advertising of their business at that cost, he did not deem it either prudent or necessary—and the result is that to-day improved gas lighting sheds its brilliancy and warmth of light around the residence of the Lord Mayor, the Bank of England, and the Royal Exchange, of London.

The result, in both of these cases, has been a development of a more correct and a greatly improved system of gas lighting. The fact has been demonstrated that each system has a field of its own, and that instead of one system replacing the other, that they are co-ordinate branches of illumination, that they are to exist side by side perhaps, but that every development of electric lighting must result in an increase of the use of gas and an improved method of using it. That there is an increase in the application of electricity to various purposes is shown by the fact that there are companies organized in England, for supplying the electricity and the machinery and paraphernalia incident to its use in lighting and power, whose aggregate capital amounts to over 12 millions sterling.

That the investment of this amount of money has not yet extinguished gas is also shown by the fact that both in London and Paris new works are constantly necessary to meet the rapidly increasing demand for gas. At the Annual Meeting of the British Association for the Advancement of Science, on the 23d of August, the President, in his address, passed in review the whole subject of the relations of gas and electricity.* Of all the men of science of the present day, no other one is more eminently practical than Dr. C. W. Siemens, the President of the Association for the present year. No other man understands better the practical application of science to the every-day wants of the world than he; and it is exceedingly doubtful if any one else has ever been so successful in making science pay, as is evidenced by the accumulation of the very large fortune which has resulted from the business to which he has, with such wonderful success, applied the results of his scientific research. Bold in his investigations, he is equally frank in giving the results obtained to others. Thoroughly acquainted with both electricity and gas, and being largely interested in both, he frankly states that while he does not see his way to such a cheapening of the electric light as to render it available generally, "Gas will still be the poor man's friend," and for heating purposes should supersede coal both for domestic and mechanical uses—since while steam yields, in mechanical effect, one-seventh of the energy of the coal, the gas engine yields as much as one-fourth. And, considering the progress made in gas burners, the Doctor says, "More progress has been made in the past five years than in half a century before; and it may well be that still further progress, no one can say how great, may even now be in store for us."

With the facts obtainable almost every day, and with the opinion of such a man as Dr. C. W. Siemens to sustain our statements, we deem that argument is unnecessary. All that the gas engineer need do is to bend all of his best energies to the development of his own profession, and give himself no uneasiness about the success of others engaged in other branches of scientific development.

The Petroleum Outlook.

The outlook in the producing region is anything but flattering to those who look for better market values.

In the Bradford field, although there is little or no activity in operations, the production seems to be declining very slowly. This is due largely to the fact that production from this field comes from a great number of wells, which are carefully handled and worked.

In the Richburg field, while there are few new operations to report, the completing of wells in progress has been considerable, and the production for July shows a slight increase over that for June. The wells in this field likewise exhibit wonderful tenacity. So far is this the case that it is now regarded as the most permanent field ever found.

The large wells in the Cherry Grove or new Warren field, in the latter part of last month generally showed a great tendency to weaken. This tendency has since then been considerably counteracted by the use of small torpedoes, which seem here to act with a more than usually beneficial effect. The result of this has been a large and sudden increase, which is likely to be made still greater when tankage and pipe line facilities are built to take care of the excess. This field seems to be measurably defined at the north, east, and west, but its southern terminus is still somewhat uncertain.

In the Butler field the Schidemantle well has come in as a five hundred barrel "gusher." It has had the effect of creating a considerable degree of activity in that quarter, notwithstanding the present low prices of oil. Several large purchases have lately been made by prominent operators, and we may look for enough immediate development to contribute largely to the uncertainty of the "oil future."

*See page 138.

A "wild cat" or pioneer well was struck in Forest county, (near the Warren county line and about six miles from the Cherry Grove district) which seems to be attracting considerable attention. It is located on a forty-five degree line from what is called the Sheffield development. It is worked at present as a "Mystery" but there are enough evidences concerning it to make some of the trade believe and all to fear that it will turn out a considerable well.

The situation in refined oil is no more reassuring than in crude. The warehouses at the seaboard are stocked to fullness with refined, awaiting vessel for export, while Europe generally seems well supplied with present stocks. Our German, Dutch, French and English circulars, lately received, all agree in showing stocks at the five principal ports and in London, to be considerably greater than they were at the corresponding times last year. Added to this it is possible that Turkey, Egypt, and probably India will take less oil from this forward than they took last year.

Taking the whole situation together, we can see no reason to give confidence to the holders of oil, for better prices in the near future. Nothing but speculation would be likely to move the market at present, and the present outlook seems so bad that there is nothing to stimulate the hopes of even the most heroic speculator.—Stowell's *Petroleum Reporter*.

Obituary.

COL. JAMES ARCHER.

We are obliged to announce the death of Colonel James Archer, of Denver, Colorado, the original founder of the Denver City Gas Light Company. His death occurred during the last week of August, and beyond the fact that it happened very suddenly, we have no further details.

At a joint meeting of the stockholders and directors of the Denver Gas Light Company and the Denver City Water Company (of both of which concerns he was President), held on the 28th day of August, 1882, a committee, consisting of Messrs. George W. Clayton, Daniel Witter, George W. Kassler and William J. Fay, was appointed to draw up a set of suitable resolutions indicative of the sentiments of those with whom he had been so long associated in business.

The remains were taken to St. Louis, Mo., for interment; and Messrs. William J. Fay, George Clayton, Richard Holme, and William R. Mills accompanied the body from Denver to its final resting place.

The Institution of Mechanical Engineers.

At the summer meeting of the Institution, held at Leeds, the President, Percy G. B. Westmacott, in his address, spoke the following:

We may pride and plume ourselves upon the vast strides which science, art and engineering have made in our time; but posterity will assuredly lay its finger upon the great blot of waste, and may stigmatise our age as the Black Age, which has spoiled, by careless, unnecessary and selfish emissions of smoke and noxious gases, many a noble town and many a lovely spot on earth.

The smoke nuisance is altogether inexcusable, and cannot be too severely dealt with. Science and art have practically overcome it; and experience enables many, like myself, to assert that money can be profitably laid out and yield good interest in the abatement of this unpardonable nuisance. Then, with regard to waste, much ingenuity and skill have certainly been displayed, and much work has already been done, to lessen this evil; and the records of our institution will bear witness that many of our members have striven and succeeded well in their efforts to remove this stigma from our age.

I would urge upon the younger members of our profession to study this question profoundly, and as if the whole of their success in life depended upon it; and never undertake the smallest piece of work without wrapping it round with economy. Those who carry out this advice will assuredly succeed. May I not go so far as to say that no really good and useful invention is ever wasted or completely thrown aside, even though it may be superseded permanently or for a time by some other invention? This, to my mind, is an important reflection, one extending far beyond professional views; for its realization would greatly assist in alleviating those injurious alarms which are often felt when some new and striking invention bursts upon the world. To illustrate this, let us take for an example the present prominent question of lighting.

We may go back to the period when the diffusion of light depended upon oil; after a time candles were introduced; then came the great and important invention of gas; and now, at the present time, electricity is being brought into use. Well, what do we find in all these competing agents, each good and useful in its way. We find that not any one of these sources of light exercises a monopoly. Candles have not interfered with the use and progress of the oil lamp; gas has not snuffed out candles, or stopped the flow of oil; and I do not hold with those who believe that electricity will totally eclipse gas.

Dangers of Steam Street Pipes.

An illustration, says the *Scientific American*, of the possible dangers of the system of public steam supply which is now rapidly coming into vogue, is furnished by a recent accident at Lynn, Mass. In that town steam has been supplied for some time to customers by means of pipes laid in the streets, and on a recent Monday morning one of the street mains blew up with a loud explosion, hurling stones and gravel in every direction to a distance of forty or fifty feet. Nearly every window in the neighboring buildings was broken, and some of these received other injuries, while a woman who was passing by was seriously hurt. The accident is explained by the daily papers, in their usual satisfactory manner, as having been due "to accumulation of water in the pipes." It seems that this is the third explosion of the same kind which has taken place in Lynn within two weeks. After the first one an engineer was discharged on the ground that his carelessness "in allowing water to stand in the pipes" had caused the accident, but he appears to deny his guilt, and says that "the system of pipe laying is not correct."

Whose fault this may have been we do not care to inquire, but we may suggest that it would not be very difficult to ascertain in case of need. Meanwhile we trust that the engineers of the new steam heating companies of other cities are laying pipes which they are sure will not burst out of resentment at being improperly laid, or because of water being allowed to stand in them. An explosion in Broadway, for instance, would be a serious matter, even if it amounted only to the hurling of a few hundreds of paving stones over the passers-by, and through the plate glass show windows which line the streets.

Correspondence

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

Visit of New England Gas Engineers to Waltham, Mass.

To the Editor AMERICAN GAS LIGHT JOURNAL:

By kind invitation of the Directors of the Waltham Gas Light Company, and the Davis & Farnum Mfg. Company, the gas engineers assembled at Waltham to inspect the new and elegant works, and to visit the world-famed factory of the American Watch Company. Under the careful guidance of Mr. Tarbell, engineer of the Waltham gas company, we first went through his new works, observing all the improvements, and admiring the beautifully kept lawns and tasty grounds by which they are surrounded. After luncheon the party went over to the watch works, where they were met by Mr. Robbins, the Treasurer, who very kindly escorted them through the bewildering labyrinths. The different rooms, viz., annealing, finishing, dial, jewel (the latter most attractive to the younger visitors), were thoroughly inspected; and, surely, it is no boast to say that an exhibition of this kind was scarcely anticipated by anyone of the party, and numerous were the expressions of wonder and delight.

The company now employs over 2,000 hands; and, by building a new wing, hopes to accomodate an additional 500 this coming Spring. After "doing" the watch works as thoroughly as time would permit, the company went down to the Charles River, where lay the White Swan ready for the gay excursionists. After a delightful sail on the winding Charles, the grove was approached where the hungry and thirsty were to be refreshed. Here, in order to procure an appetite for dinner, the bowling portion inveigled a few green ones, and soon the balls rolled merrily until the signal for dinner was given. To say that the dinner was good would be faint praise, it had also another decided advantage over a dinner, not long ago, where the aid of steam stokers was invoked as the only means to obtain something. Thanks to the untiring efforts of Mr. Tarbell, the genial host, our spirits rose as the dinner advanced, so much so that an impromptu go-as-you-please race was improvised, and won, amidst thundering applause, by the gentleman from New Hampshire.

Letters of regrets were read from General Roome, Joseph R. Thomas, W. H. Price, and others. A vote of thanks, by motion of Mr. Stiness, was passed thanking the Directors of the Waltham Gas Light Company, the Davis & Farnum Manufacturing Company, and Mr. Robbins, the Treasurer of the American Watch Company, for the courtesies shown on this occasion.

After short addresses by Pres. Slater, Colonel Spaulding, Messrs. Yorke, Neal, Gerould and Stiness, the party adjourned for the purpose of having photographs taken. After this had been successfully accomplished, and three rousing cheers and a tiger, given with a will, for our blushing host, Mr. Tarbell, the company embarked, *en route* for home. And thusly endeth a most delightful and entertaining, never-to-be-forgotten visit to our friends at Waltham.

O. B. W.

[From the London "Journal of Gas Lighting"]

The Application of Gas to the Lighting of Open Spaces and Large Buildings.

A paper read by William T. Sugg, Esq., at the meeting of the Gas Institute, Birmingham, Eng., Wednesday, June 14, 1882, with the discussion thereon.

It has very frequently been asserted by men of high position in the world of commerce, as well as by eminent scientific men, that the electric light is more suitable than gas light for illuminating large areas. It is to be presumed that this dictum has been received as something absolutely true by a large section of the public. Chairmen of gas companies, in their half-yearly speeches, have even said pretty much the same thing, and have seemed almost to believe that really gas has no chance against the electric light, at least for large open spaces. In parentheses let me say that it is also true that lately Professor Crookes and other learned authorities have told us that gas is neither so cheap nor so good as electricity for small spaces.

The House of Commons were actually moved by the statements everywhere made to order a trial of the most publicly favored specimen of the electric light for the purpose of lighting the Parliament Chamber, instead of gas, which was declared by some to be obsolete, impure, and deleterious to the atmosphere. The electric light, however, did not succeed, notwithstanding the permission given to the Brush Company, even to alter the ceiling by lowering a number of square glass lamps of considerable length down into the interior of the chamber. Gas was found to be superior to the Brush electric light for lighting the House of Commons, which is a large interior space. And here it is necessary to say that at no time, either before or after the experiment, could the heat or the products of combustion from the gas mix with the air supplied to the House, for two reasons—first, the pure air is supplied from below the floor, rising continually, and the vitiated air is carried off through the ceiling; secondly, because the gas burners are fixed above the ceiling, which is of glass, and help to carry off heated air from the interior of the roof through their own ventilators, each one being separately ventilated.

Popular prejudice, however, does not reason; and there are still found men in high positions who repeat the same fallacies. Only lately the Commissioners of Sewers of the City of London invited tenders for lighting several of the streets of the city by electricity, and it was declared by one of their number (Mr. Innes) that the contracts they had before them showed that the electric lighting involved an expenditure of more than five or six times the amount then being paid for lighting by gas.

The same body refused to pay three times the cost of the old lighting by gas for a new and superior system, which gave nearly six times more light than the old; and yet this new system of lighting streets by gas has often been declared by the public press and by the general public to be superior to the electric light. Still more recently they have averred, as a reason for not adopting gas for the better lighting of the streets, that the Brush Electric Light Company were supplying their lights, under contract, for the same price as the Commission paid to the Gas Light and Coke Company for the 5 feet per hour lamps previously used. Yet it is a remarkable fact that the Siemens electric arc lights (which are produced certainly at as cheap a rate as any electric light now before the public) could not be supplied at a less cost than five or six times the price of the original gas lighting; and it is a more remarkable fact that the Brush Electric Light Company did not offer to supply the whole of the city on the same terms as those under which they are now supplying Ludgate Hill and Cheapside, considering that it has been so frequently stated by their advocates that they can supply light for streets and open spaces at the same rate as gas.

It is true that it is now asserted that if they were allowed to light shops off the same wires as those supplying public lamps they could do the electric lighting more cheaply; but they do not say how much more, neither does it appear that public and private lighting on the same wire could be managed with either safety or profit. But notwithstanding the figures of the tenders received and this positive commercial assurance that no one is willing to supply at a lower rate than five or six times the cost of gas, yet it does not seem to occur to the Commissioners that they might try gas for the purposes they require until electricity is proved to be able to do the work better and more cheaply. The reason they do not try gas can, I believe, only be because they really think the electric light is superior to gas upon all points for this purpose.

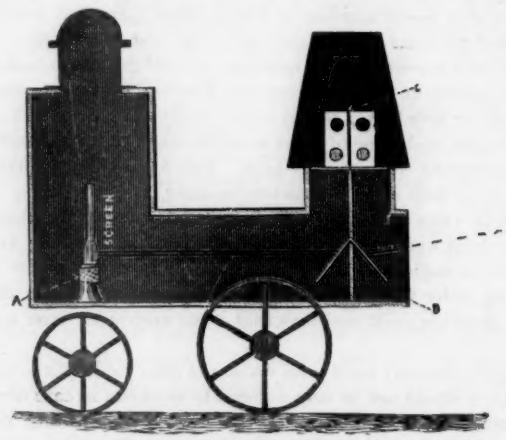
From the first, since I saw the electric light in Paris, I have never had but one opinion upon the subject, and that is, that whatever may be the proper use of the electric light—either the arc or the incandescent form—neither of them is so suitable for lighting large spaces as gas. I quite feel that, coming from me, this sounds very much like "There is nothing like leather;" but my opinion is founded on careful observations of electric lights in use, joined to a study of the system on which they are worked, and I think I can show a good foundation for my assertion of the superiority of gas.

First, as I stated in my letter to the *Times*, published on Oct. 11, 1878, the electric light is deficient in volume. What I mean by this I will illustrate in the following manner: It has long been customary—previously to the introduction of gas and even since—to light large spaces where such work as the unloading of barges on rivers, the loading and unloading of heavy goods, and general rough outdoor work is being performed, by means of braziers, or, as they are generally called, "devils." These braziers are usually from 12 to 15 inches high, and about 10 or 12 inches broad, and when the coal or coke with which the are filled is in a state of low incandescence—viz., orange red—they diffuse a large volume of light, which covers a surprisingly wide space. The shadows of projecting objects on the ground are very slight, and for this reason this kind of illumination is often thought to be superior to other systems of lighting, more especially for work done on the water. I believe that one of these braziers, of large dimensions, used as a lighthouse light, is said by mariners to be more useful in very hazy weather than the most improved lighthouse lamp. I think, however, this is not correct, because the volume of light, though extremely great, is of too low intensity to enable it to penetrate through even a slight mist as the light from a Wigham gas burner such as is used at the Howth Bailey light, off the coast of Ireland, or the improved lamp now in use by the Trinity Board, and improved by Mr. J. N. Douglass, their engineer. Professor Tyndall has declared the Howth Bailey gas light to be superior to the electric light for foggy weather. But the amount of light developed by an ordinary brazier such as I have described may be taken as generally not less than from 600 to 1,000 candles, according to the degree of incandescence.

Now the very opposite to this light of low intensity and great volume is the electric light. The brazier has a radiant illuminating surface of about 500 square inches, one-half of which is fully available in any direction. An electric light of 1,000-candle power has only a total illuminating surface of about 12 square tenths of an inch, only 6 of which are fully available in any direction. The comparison of radiant illuminating surface is therefore as 50,000 is to 6; so the brazier possesses 8,000 times more radiant illuminating surface than the electric light. This latter is therefore a light of high intensity, but of low volume. In the Dover lighthouses the electric lights are of about 7,000 candles, measured in the photometer, and when placed in their admirably arranged Fresnel dioptric lanterns, the small but very intense point of light is developed out into a large surface of light of much lower intensity but greater volume, and they have a radiant illuminating surface of about 36 square feet. At 20 miles distance on a clear night the lights appear to be about the size of one's hand, or sometimes even larger than this. Now it is evident that if the lanterns were taken off, and the naked light only shown, at a comparatively short distance from the shore the apparent size of the light would not be larger than a pin's head, although it would still possess in itself the full measured or nominal light of 7,000 candles. This light would, however, be useless to cover the space required, or to enable it to be distinctly seen by the naked eye at a very few miles from the shore. It is even probable that the light of a candle, or at least a small lamp, would at a short distance be more effective than this powerfully intense electric light. It is therefore clear that a light suitable for large spaces, or for lighthouses, must possess not only a certain intensity, but also a certain volume corresponding to its intensity.

To bring this point more closely home, I propose to instance the electric light in the city and on the Thames Embankment. It has been stated in the public prints that the Jablochkoff lights on the Thames Embankment are equal to 300 or more candles, and that the Brush electric lights in the city are equal to 2,000 candles. I am not disposed to say that they would not realize something like these figures if taken out of their lanterns, at their best state of burning, and placed at a suitable angle in a short photometer. But I have found that when they are tested in their places as they are used in their lanterns or globes on top of lamp columns 11, 13, 15, or 16 feet high, they do not actually realize these illuminating powers.

The accompanying table of experiments made on two clear nights lately will give an idea of the amount of effective light which really reaches the ground. The standard of light that I have used for comparison is a Keates's lamp burning spermaceti oil, provided with a Methven slit placed across the flame of the burner, instead of vertically as in the Methven standard of light. The slit is of such size as to allow a portion of the whole light of the lamp equal to 2 candles to pass through it. This standard light, which I find is constant, is enclosed in a dark chamber properly ventilated; the front part of the chamber communicating by means of a square wooden tube with one side of the comparison disc. This disc is shaped like the letter A, and covered on both sides with white paper. On each side of the disc is pasted a cutting from a newspaper, one-half the reading being on one side and the other half on the other. The two sides are separated by means of a partition, which is carried up some distance above the discs. One side—that nearest the lamp—is covered so that no other light but that of the lamp can fall upon it; the other side is left open to receive the full light from the electric or other light to be examined. A mirror properly placed enables the observer to see both sides of the disc at once, and thus to judge of the relative amount of light falling on each. The standard degree of light I have adopted is therefore equal to that which will fall on a white surface from the rays of two candles placed at a distance of 3 feet from that surface. The photometer as



PORTABLE PHOTOMETER.—A, standard of light, with screen in front; B, adjustable reflector; C, reflected image of the two discs standing on a glass table. The dotted line shows the angle of light for the lamp being tested.

thus used is on the Church and Mann principle, as you will perceive; but it may be arranged on the King principle, and thus be used to measure the amount of light falling in any part of a roadway at a distance of 3 feet from the ground.

Experiments on Two Separate Nights with Various Electric Lamps.

	Position.	Horizontal Distance.	Vertical Height.	Actual Distance	Size of Gas Lamp calculated to produce the same Result.	Time.
		ft. in.	ft. in.	ft. in.	Candles	h. m
1	Lamp on kerb under Waterloo Bridge.....	26 3	8 4	27 7	169.0	10 25
2	First Post, Somerset House.....	34 3	13 0	36 8	297.0	10 35
3	Same with violet rays..	35 6	13 0	34 10	269.0	10 39
	Medium..	29 0 } 32 3				
4	First post, Temple Station from Westminster (lamps going out)	31 3	13 0	33 6	249.0	10 45
5	First post, Temple Library	31 10½	13 0	34 3	259.0	10 55
6	Second post fr'm Blackfriars Bridge toward Westminster	31 9	13 0	34 1	258.2	11 5
7	At Refuge (Brush), Blackfriars Bridge...	48 8	17 0	50 6	557.2	11 15
		46 3 } 47 6				
8	In front of *Times* office (same side)	81 0	14 6	81 3	1466.6	11 25
		80 0 } 80 6				
9	Corner of Ludgate Stn.	29 7	11 10	31 6	120.4	11 50
10	Brush, corner of Bride Lane, with photometer down lane	50 0	11 6	51 3	582.4	11 55
11	Do, with photometer toward bridge	39 0	11 6	40 4	320.8	12 0
12	Do, with photometer across road	33 0	11 6	34 9	267.4	12 5
1	Lamp next land'g steps	25 0	13 0	28 3	177 4	10 30
2	Fifth Lamp from Westminster Bridge.....	22 8	13 0	26 1½	150 2	10 35
3	Fourth do	17 6	13 0	21 10	107 4	10 45
4	Same with photometer to kerb.....	18 8	13 0	22 9	114 4	11 10
5	Next Floating Baths, with fluted glass lantern.	30 6	13 0	33 3	242 0	11 20
6	Lamp on kerb under Waterloo Bridge.....	29 3	8 4	30 4	204 0	11 30
7	At Refuge (Brush), Blackfriars Bridge...	33 7½	17 0	37 9	315 4	11 50
8	No. 9 Brush Lamp, in	28 8	11 10	31 5½	220 4	11 55
	Bridge street.....	29 8 } 29 2				
9	Do, burning low.	23 3	11 10	26 1½	150 2	12 0
10	Do, with moon in direct line.....	26 2	11 10	30 9	209 0	12 8
11	Corner of Ludgate Hill Station	20 0	11 10	23 3	119 4	12 15

Note.—Standard, 2 candles, 3 ft. from disc; height of disc from ground, 3 ft.

Illuminating Power of Different Kinds of Gas Lamps as Burning in the Public Streets in Various Parts of London.

No.	Horizontal Distance.	Vertical Height.	Actual Distance.	Angle of Rays of Light.	Result.	Time.
	ft. in.	ft. in.	ft. in.	Deg.	Candles.	h. m.
1	44 11	15 4	47 7	19	501.4	10 35
2	22 0	9 0	23 9	23	125.3	10 50
3	42 4	12 10	44 4	17	436.0	11 40
4	27 4	10 3	29 2	21	188.0	10 55
5	28 1	10 0	29 8	20	195.0	10 58
6	38 5	15 6	41 5	19	380.0	11 40
7	42 6	15 6	45 4	20	456.0	11 10
8	30 8	8 6	31 9	16	224.4	11 30
9	37 3	14 0	39 9	22	350.3	11 33
10	36 9	12 9	38 9	19	290.0	11 48
11	29 6	12 9	32 3	23	232.0	11 50
12	20 10	8 9	22 7	23	113.2	11 58
13	29 7	11 6	31 10	22	224.6	12 4

Note.—The standard was 2 candles, 3 feet from disc; height of disc from ground, 3 feet.

On the 5th of the present month, on a very fine, clear evening, I found that at 11.10 P.M. one of the Jablochkoff lamps (No. 4 on the list) on the Thames Embankment gave a light equal to 2 candles at 3 feet from the disc at a distance of 18 ft. 8 in. in a horizontal line. The height of the post above the level of the disc being 13 feet, the angle of the ray was 35½ degrees. (See accompanying diagram.) This being so, a gas lamp of the nominal power of 114.4 candles would, according to calculation, give a like result. As a matter of fact, however, a gas lamp of the nominal power of 60 candles, consuming 25 cubic feet of gas per hour, which has, with a great many others of the same kind, been burning in the public streets for many months past, gave on the 9th of June (when measured by the same standard) a light equal to 125.3 candles. The distance from the post was 22 feet in a horizontal line, and the light was 9 feet above the disc of the photometer; the angle of the ray was therefore 23 degrees.

It is necessary to mention here, in order that you may understand clearly the bearing of the observation as to angles, that in a published report which I have before me, dated May 24, 1882 (see Appendix), Professor W. E. Ayrton and Mr. John Perry say that "with all electric lights the intensity of the illumination is different for different angles in the same vertical plane;" and as the summary of the results of their observations at different angles of inclination they give the following:

Horizontal	1129	Candles per horse power electrically given to the lamp.
17 degrees	2637	
34 degrees	3042	

The electric light, therefore, in this instance appears to have the least angle. I think you will perceive from these facts that if the cost of the electric lights is a slippery subject to get hold of, the estimation of their illuminating power is enough to puzzle the most experienced photometrists.

At the refuge near Dr. Keyser's Hotel at Blackfriars, I found on the same night that the Brush electric light there produced the standard light of 2 candles on the disc at a distance of 47 feet 6 in. from the post in a horizontal line. The height of the post was 17 feet above the photometer disc; the angle of ray was therefore 20 degrees. Consequently, according to calculation, a gas burner of the nominal power of 557 sperm candles would have produced the same result. As a matter of fact, on the night above stated, at 10.35 P.M., a gas lamp which has been burning in the public streets for many months, gave (measured by the same instrument) a light equal to 501.4 candles, with a consumption of 90 cubic feet of gas per hour, at a distance of 44 ft. 11 in. from the post in a horizontal line. The height of the lamp above the disc was 15 ft. 4 in.; the angle of the ray was therefore 19 degrees. In this instance the Brush light had slightly the best angle.

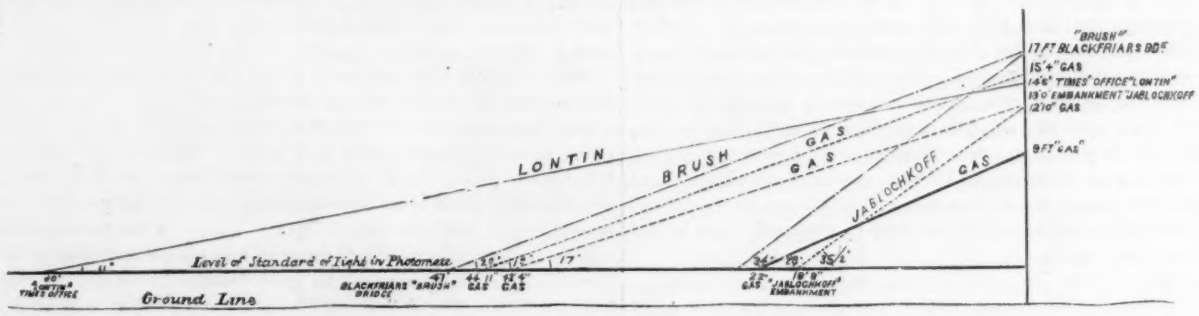
In both cases the gas lamp gave a constant light, and the electric light did not. The gas lamp gave its light the same in all directions round the post. The electric lamp in the latter case did not appear to do so; the results being:

Down Bride Lane	582.0 candles.
On pavement toward Bridge, at right angles with Bride Lane	320.8 "
Across road in direct line with Bride Lane.	267.4 "
Total	1170.2 candles.
Average of the three observations	390.2 candles.

Nearly in front of the *Times* office, in Queen Victoria Street, is a lamp on the Lontin system, which produced the standard light on the disc, at a distance of 80 feet 6 in. from the post on a horizontal line. This is the most powerful light I have yet tested. To produce the same amount of light by gas would require a lamp of 1,466-candle power. Calculating from the results given in respect of the gas lamp before mentioned, a similar lamp of larger dimensions, and consuming about 280 cubic feet of gas per hour, would equal this light.

Those of you who have seen the electric lamps and some of the larger gas lamps in use in all parts of the country, the nominal illuminating power of which does not exceed 300 or 400 candles, must have remarked that the nominally much more powerful electric lights do not light the ground better than those gas lamps. It is a remarkable fact that although, at the Electrical Exhibition at the Crystal Palace, the electric lights in that part of the Nave where the Kings' and Queens' screen is numbered many thousands of candles, it was not possible from the Center Transept to tell the time by the large clock at the south end of the Palace, which is much more than 20 feet in diameter, and has figures above 6 feet in length. Yet I need not tell you that if that part of the Palace had been lighted by gas to a tithe of the nominal number of candles which the electric light was said to represent, it would have been a very easy matter to read the time on a much smaller dial.

You will naturally expect that I should be able to give some reason for this curious fact. This reason is another of my arguments why the electric light is not so suitable as gas for lighting large spaces. The electric light is composed largely of highly refrangible rays which move at a very high rate of velocity. To illustrate this, let me refer for a moment to the brazier. There we have a great number of heat rays which are the least refrangible,



and which are generally supposed to be invisible to our organs of sight, because of the comparatively low rate of speed at which they move. But this heat ray, as pointed out to us by Professor Tyndall, is an enormous mountain amongst the other rays of the solar spectrum. And between this heat ray and that part of the solar spectrum approaching to yellow there are a number of dark red, red, bright red, and orange rays of low refrangibility and slow movement, which are useful to us when they are not interfered with by the more rapidly moving and more highly refrangible rays which irritate the optic nerve most violently, and render it as it were insensitive to the rays of low intensity. Captain Abney, of South Kensington, who has done more than perhaps any man living to elucidate the theory of photography, has shown us that even the red ray can be photographed, and thus that it probably must have a sensible effect on the human eye, more useful for the purposes of vision than has before been supposed.

Now the electric light, compared with the brazier, possesses few heat rays, but has an enormous quantity of rays belonging to the other end of the solar spectrum; notably the other invisible ray which is the antithesis of the heat ray—I mean the actinic or chemical ray. Professor Tyndall tells us that to produce the extreme violet rays the retina of the eye is struck 789 millions of times in a single second, and that at this point the retina ceases to be useful as an organ of vision. This ray is, however, the most useful to photographers, but does not appear at all useful in artificial lighting. On the contrary, nature provides us in summer evenings with a light which is good and strong enough for working indoors as well as out, and which, after the glare of full day, is most acceptable to the sight. The light is pure or very slightly yellow or rosy from the last beams of the setting sun, but is almost devoid o

the actinic or violet rays, although it possesses the pale green ray and all the others from that toward the red. Therefore it is grateful to the sight, and is powerful to illuminate us; in fact, it possesses volume and sufficient intensity without the violently refrangible and high-velocity rays which require the strong golden beams of the sun to correct and tone down their effect, and prevent them from being injurious to the human eye.

This evening light is, in my opinion, what we require to replace the light of day after the sun has set. But this we most decidedly do not get from electricity in the arc form, as it is now used for lighting large interior or exterior spaces. But we can obtain such a light from gas, as I shall be able to show a little further on. Lastly, the highly refrangible rays are scattered and diverted from their course by molecules of water, and do not reach the point to which it is the intention they should be directed, even in the ordinary moist state of the atmosphere on a fine evening.

Here it is necessary to mention another fact for which we are indebted to the scientific research of Professor Tyndall—viz., that a ray of light is absolutely invisible unless it strikes upon something which may reflect it. Now, bearing this fact in mind, and remembering also that the heat and red rays, in passing through a globe of water, go nearly straight through—all the others (the orange, yellow, green, blue, and violet) being more and more bent out of their course in the order in which I have mentioned them, till in this last visible ray, still more in the actinic ray, they reach their highest degree of refrangibility—it is clear that a light which is largely composed of these rays cannot be so serviceable for artificially illuminating a space, whether interior or exterior, as one that possesses the most rays of a lower refrangibility, combined with a sufficient volume of those rays which give intensity to the light. This is the combination which we have readily available in gas light.

It has been and will be argued that gas can never represent that mellow evening light which I have spoken of. On this point I have to recite a most interesting experiment which has only been tried within the last few days. I have spoken of the lighting of the House of Commons, and mentioned the failure to give equal satisfaction to that experienced with gas lighting, which resulted from the trial of the electric light proposed to be employed instead of gas. From what I have said as to the peculiarities of the arc light, you will, I think, be able to see why it could not be so successful as gas.

It has been urged that the color of the gas light is not like that of day—it is yellow and smoky. In the House of Commons it is not easy to show whether it is or is not like the daylight, because the gas light does not come from the same point as the daylight, and therefore the change of position tells us when gas is lighting the House. But in the new Reading Town Hall, which was opened on the 31st of May last, the architect has arranged a glass cove round the hall under the ceiling line. The daylight enters the hall first through skylights on the external roof, and then descends through the glass cove. Behind the glass cove, at a short distance from it, are placed the gas lights, each of 100-candle power, and each provided with a ventilating shaft to carry off the products of combustion. Thus the daylight and the gas light enter the hall from the same points; the consequence being that the following experiment, as to the relative color of gas light by daylight could be and was tried on the opening day:

A concert commenced in the hall at half-past seven, or at the time when the area was well lighted by the evening light I have spoken of, so that small print could very easily be read in any part. The last beams of the setting sun fell on the skylights of the roof, producing a fine mellow, soft, white light. The gas was then turned on to its full power—9,000 candles for the entire hall. No difference could be detected in the light till the concert came to an end at eleven o'clock. The daylight gradually went, and the gas light imperceptibly took its place; and it was remarked by everyone that the change from daylight to gas light had not been noticed. One of the public journals of Reading mentioned this fact. So much did the gas light resemble daylight that some of the audience found that it was dark when they went out of the hall, between the parts, having imagined they had been sitting in daylight all the time.

It is remarkable that when the daylight was lighting the hall and the gas lights were turned full on, they did not appear to alter the color or illuminating power in any way. But as the daylight disappeared they took up the lighting. Like the House of Commons, this hall cannot be in the least degree affected by the heat or products of combustion from the burning gas.

This, then, I say, fulfills all the conditions of artificial lighting as to color, softness, and volume of light, with perfect steadiness and control, an absence of highly refrangible and chemical rays, and with no products of combustion to vitiate or heat the atmosphere. Is not this, I ask, a suitable light for any of those museums or libraries of which we have heard so much? And does any system of electric lighting fulfill any of these conditions so well as gas?

As to open spaces, where the combustion products can escape into the air, the conditions of lighting, however difficult to fulfill by an electric system, are easily and silently done by gas without the least uncertainty, and with an entire absence of supervision at any of the points of illumination. More than this, gas is steady; and I only wish anyone who likes to talk about the steadiness of the electric light would try it *in situ* in the public streets as I have done. He would soon find that the difficulty experienced by the Irishman in counting one of his little pigs is one of the things still to be got over by the electricians before gas can be abolished.

I think I need not in this paper, which is sufficiently long already, mention anything with regard to the lighting of large spaces by incandescent lamps. Although the color of the light is more nearly approaching the proper conditions of useful artificial light, yet it is abundantly clear, from the number of lamps always required to light even a small space, that they do not possess much volume. Independently of this, their extreme delicacy will probably preclude their employment in places where delicate fingers are not constantly available for their careful manipulation. These cannot, for open spaces, such as squares, railway stations, docks, etc., pretend to any serious rivalry with gas, either in point of usefulness, steadiness, readiness, or cheapness.

As regards the lighting of large interior spaces, such as workshops, in which there are particular dangers from fire to be guarded against, it has been stated and believed by the public that gas cannot so well be employed as electricity. Let me just instance the large new workshops of Messrs. Mowlem, Burt, and Freeman, in Westminster, which, after serious consideration and visits to electric lighting exhibitions on the part of the principals, was finally lighted by gas, after a clearly demonstrative experiment that this system was cheaper, readier, better, and safer than any electric light. I am authorized by these gentlemen, who have expressed themselves thoroughly satisfied with the lighting, to say this. The gas lights, each of which equals 100 candles, are enclosed in lanterns, which are locked, and are lighted by flash jets left burning inside without opening the lamps. Therefore, although there are small shavings constantly flying about from the machinery, none of them come into contact with the lights. The experience of incandescent and other electric lamps does not show them to be any safer than gas.

It is the case that from time to time gentlemen having a very little acquaintance with gas and less with electricity rush into the columns of the *Times* and other journals and give particulars of the cost of electric lighting in comparison with gas. With that delightful archness which arises from their ignorance, they usually omit from these calculations the not unimportant items of rent, rates, and taxes, and the most important item of all—profit. Perhaps, under the circumstances, they ought to be pardoned this latter omission, as it is generally believed that it has not yet appeared in electric lighting accounts, excepting in the way of speculation.

But I feel that it is needless to weary you and myself with any attempt to demonstrate the relative cost of electricity and gas till some scientific conclusion is arrived at as to what is an electrical horse power. How is a horse power to be electrically given to a lamp? What is an electrical candle? What is the proper angle at which electric lights are to be examined; and, consequently, what is the corresponding angle for the gas light to be tested in comparison with any electric light? Lastly, is the principle that light decreases as the square of the distance to rule the construction of electric photometers as it does those used for gas? Sufficient for me, in this paper, to feel that I have proved that gas is steadier and readier, and more useful for the purpose of lighting large interior and exterior spaces than electricity.

The *Times*, in its issue of the 3d of June, had a leader on the prospects of electricity, and after mentioning that, according to Professor Crookes, the incandescent electric lights will be cheaper than gas, when certain charges incidental to the mode in which he obtains his power have been disposed of, says:

"It must be remembered, however, both in regard to this and to street lighting, that any comparison now made, in respect either of cost or of illumination, is made with gas very imperfectly applied. Gas when first introduced presented so many advantages over the lights which had preceded it that it afforded an amount of satisfaction in excess of its actual merits; and it is still being consumed in many places on a plan which in the present day may almost be called barbarous. Within the last few years greatly improved burners have been introduced, and the attention of gas engineers has been keenly directed to the subject by the competition of electricity. There are many streets in London which show how much ordinary gas lighting might be improved, and there can be little doubt that the improvements now to be seen are but the precursors of others. It would therefore be premature to suppose that the claims of electricity will have to be weighed only against those of gas as now commonly employed, and not against gas employed under more advantageous conditions."

Professor Crookes is a customer of the Gas Light and Coke Company to the extent of about 500 feet of gas per night for two rooms which were never before lighted by gas; so that if many of the rich go and do likewise the sale of gas is likely to be increased very considerably for lighting houses and rooms to which it was before a stranger. Messrs. Samuel Brothers, of

Ludgate Hill, the well-known tailors, light their show rooms by the Jablochkoff light, which is the electric light nearest approaching to the conditions of a gas burner or candle. They have 20 lights, and employ a gas engine which costs 2s. per hour for gas, and develops 23-horse power by indication whilst the lights are on. The illuminating power of each lamp is not known at present. Gas is an incandescent light of very large volume as compared to the almost invisible filaments from which the electric light is radiated. The comparison between the two is almost as great as that between the brazier and the electric lamp.

As the *Times* remarks, improvements are continually going on; and I can assure you, from my personal knowledge, that there is a very sharp competition in gas, independently of the outside competition of the electric light. The result of this must and will be improvements in the use of gas and of all kinds of apparatus employed with it. Those inconveniences which generally attend its use now—such as heat and the products of combustion—will disappear rapidly; and in saying this I feel I have a much more solid foundation for the expression of my hope than those enthusiasts who make use of the glib assertion, "Oh, they will get over that," to cover all those defects, which have been the faithful and never-absent companions of the electric light ever since it made its appearance four years ago.

The electric light is a scientific light, and so is gas light, and with all improvements which are capable of being made in both, electricity will find it very hard, when the novelty has worn off, to find a permanent place by the side of gas. It cannot replace it.

Appendix.

CITY AND GUILDS OF LONDON TECHNICAL COLLEGE,
COWPER STREET, FINSBURY, E.C., May 24, 1882.

We have examined the "Standard" electric light at the Crystal Palace, making photometric observations of the illumination in standard candles, and simultaneous measurements of the horse power electrically given to the lamp.

The light was examined through green glass and through red glass respectively, so as to compare the green rays of the light with the green rays of the candle, and the red rays of the light with the red rays of the candle. Photometric measurements were also made of the rays coming from the lamp at different angles of inclination, since with all electric lights the intensity of the illumination is different for different angles in the same vertical plane.

The accompanying table gives a very short summary of the results—a considerable number of measurements having been made at different angles of inclination:

Angle of Rays coming from Electric Light to Photometer.	Mean Number of Standard Candles per Horse Power electrically given to the Lamp.
Horizontal	1129
17 degrees	2637
34 degrees	3042

The illumination is measured in standard candles, and represents the *true* candle power of the lamp.

The light was white, exceedingly steady, and free from all blinking, the current passing through the lamp and the electo-motive force between the carbons varying very little through the whole of the measurements.

(Signed) W. E. AYRTON.
JOHN PERRY.

DISCUSSION.

Mr. C. R. Mead (Sutton) said that Mr. Sugg had added one more to the many obligations due to him for what he had done for the gas industry. He had taken a great deal of pains to show the value of electric lamps. He was not himself disposed to disparage the value of electricity as a means of lighting, having lived long enough to see many things which were pronounced impossible become not only possible but very useful. During the time the electric light was exhibited at the Crystal Palace he went there at least once a week to endeavor to ascertain what was doing. He counted the number of engines and inquired the power; and the result, although rather doubtful, seemed to be that they had about 1,500-horse power for lighting the Palace. He was told that the arc electric light was especially good, as colors could be distinguished quite as well by it as by daylight; but presently he was told that the most useful light was the incandescent light. Now this light did not possess the quality of enabling one to distinguish colors by night as well as by day, because practically it was the same color as gas light. He took a number of people to see the electric light at the Palace, and of course in many cases their minds were made up that the electric light was the light of the future, and was to supersede gas—that it was altogether more brilliant, more convenient, and less objectionable. Now there happened to be one particular room lighted by the Edison light, and by standing in a certain position in that room one could look across a large number of incandescent lights into a room lighted by gas; and his practice was to take these gentlemen, so much in favor of electricity, into one corner of that room, and ask them where the electricity was discontinued and gas commenced. There was only one occasion out of a large number when they were able to tell him, and that was on a particular night when the wind, being rather high, caused the gas lights to flicker. Electric light and gas light were so much alike that it was impossible to distinguish them had it not been for the flickering. As to the cost of lighting, one town he had to do with was very badly lighted by the commissioners, inasmuch as they adopted the old practice of getting the light at the lowest possible cost; and it was not a question of lighting the streets, but for how small a sum of money they could pretend to light them. There they had the average meter system, and employed their own lamplighters. The agent of one of the most active electric light companies was invited to tender to light the place by electricity, as it was said it could be done much cheaper than by gas. He selected a small part of the town, where there was the greatest amount of lighting, and offered to light that small part at 2½ times the cost of gas. This the commissioners declined, and then the agent said that as they had given him some trouble he ought to receive some remuneration for it. At the following meeting of the council this remarkable resolution was unanimously passed: "That if anything this gentleman has done induces the gas company to reduce the price of gas 10 per cent., the council make him a present of 50 guineas."

Mr. H. Woodall (Leeds) said the paper suggested a consideration which arose with regard to some others of a technical character, that it would be almost as well if they were read at one meeting and discussed at the next. It was perfectly impossible for members to place themselves on the same datum line as the reader of the paper. He brought before them facts which it was impossible to discuss, because they were so distinctly his own; and before they could really enter on a discussion they would require to make experiments in his own way. However, they must do the best they could with what practical experience they had. It might be known to many of the members that last October "the foremost man in all the world" visited Leeds; and, knowing that those who had in charge the arrangements for the occasion had resolved to light the banqueting room by the electric light, he (Mr. Woodall) ventured to address them on the folly of trusting such an arrangement. They fell in with the recommendation that the place should also be lighted by gas. Upon entering into the contract he found that the Brush Electric Light Company had already lighted the place, after a fashion, with six electric lamps, estimated at 2,000 candles each; consequently the banqueting room was lighted, according to their statement, with 12,000 candles. Two or three days after he had entered on his work a friend of his told him that he had been amongst the electricians, and that they were gloating amongst themselves over what was to be the upshot of the contest. They were going to show the people of Leeds the fumes of the smoky, dirty gas light on the wall by the glare of the electric light. He told his friend not to trouble himself, but to come down in the evening, when one-third of the gas burners would be lighted. At the time stated they lighted the gas lamps, the illuminating power of which could not at the utmost have exceeded 3,000 candles. The 12,000 candles of the Brush light were all on one side of the line of gas jets, but so far from the shadow of the gas flame being shown on the wall, it was a positive fact that the six Brush lamps appeared to be no more than baubles put in for ornamentation rather than to produce light, whilst the rich mellow tone of the gas light, suggestive of warm hospitality, was not diminished in the slightest degree. After the first experiment the six Brush lamps were removed, and eight Crompton lamps of 4,000 candle power were substituted; 14-horse power being added to the engine power. After that he thought the highest compliment which could be paid to gas lighting was this—that the gentlemen of the press stated, on the occasion of the banquet, that the electric lamps burnt with remarkable constancy; the fact being that three of the lamps (and those, too, in the immediate vicinity of the speakers) went out at least twenty times during the evening, and one of them altogether, and yet such was the blaze of the gas lamps, and the solid warmth and glow throughout the place, that the coming and going of these twelve thousand candles was not noticed at all except by interested parties.

Mr. G. Bray (Leeds) thought Mr. Woodall might have stated that the splendid results he had referred to were obtained by the use of Bray's burners; but he supposed he was too modest to tell the whole truth. He (Mr. Bray) must confess that he came to listen to the paper in a somewhat warlike frame of mind; however, the non-belligerent character of the paper rendered it unnecessary for him to allude to any controversial matters. It was pretty well known that there had been certain matters to settle between Mr. Sugg and himself; but he must say that Mr. Sugg had read a first-class paper, and one which, after all, must be referred to when information regarding the ostensible illuminating power of the electric light was looked for. He wished now he could stop, and say nothing more; but he felt that they were at a juncture when if he did not say something it would be looked back to, and pointed to as a time when he had an opportunity of stating what he considered his position to be with regard to improvements in gas burners, and particularly such as were to be used for the purpose of competing with

the electric light both for indoor and outdoor purposes. He could not speak on this subject without being personal to himself, if not to anyone else; and he trusted that he should be pardoned. He claimed that a most distinct departure was made in the combustion of coal gas in the year 1879. Mr. Sugg went in one direction with his Argand burners, and produced most distinct improvements; and he (Mr. Bray) went in another———

Mr. G. Anderson here rose to order. He said no one had a greater admiration of Mr. Bray's capabilities than he had; but he did not think the present was the right time to discuss personal questions.

Mr. R. O. Paterson (who occupied the chair in the temporary absence of the President) said he was, when Mr. Anderson arose, about to point out to Mr. Bray that he was exceeding the limits of fair discussion on the paper before them. The members were always ready to extend a large amount of sympathy and forbearance to any and every gentleman; but when controversial matters appeared to be looming in the distance, it became the duty of the Chairman to stop it. If Mr. Bray was prepared to discuss the paper before the meeting, he was quite sure he would be listened to with attention; but he must ask him to be brief, as there was another paper to be read that day.

Mr. Bray said he thought perhaps he might have been allowed—especially as he saw two Argand burners in front of him—to allude to the system of burners which was of his invention, and to have stated briefly his position in regard to the questions at issue between him and Mr. Sugg; but he would now content himself by referring to one remark in the paper. It was stated in the early part of it that a 60-candle power burner was consuming 25 cubic feet of gas per hour. If a burner of this kind had been compared with the electric light it would have put gas at a considerable disadvantage. With 16-candle gas and a new form of burner, which he (Mr. Bray) submitted was his invention, 24 cubic feet of gas per hour would produce a light of 80 candles.

Mr. F. W. Hartley (London) said that Mr. Sugg had given an illustration of what had often occurred to him from his own experience—namely, that as a matter of fact lights of very high intensity were always over-estimated; and he thought that Mr. Sugg had rather fallen into an error in this direction.

Mr. R. Mitchell (Edinburg) said when Her Majesty visited Edinburgh in August last it was the expectation of every person that the principal street of the city was to be lighted with the Brush light, and every encouragement was given to it by the Town Council; but when it was put up they only had it a few minutes, and it then went out. So it went on, failure after failure, until the Corporation, after discussing the matter, unanimously agreed that they could not, taking the uncertainty of it, as well as the expense, into consideration, give it any longer a place in Edinburgh. At that time it was an important matter to show the Edinburgh public what could be done in the way of street lighting at a very limited cost. Previous to this invasion of the electric light the Edinburgh people were starved with from 1¼ to 1¾ cubic feet per hour per lamp, giving a very miserable light indeed; but since the trial of the electric light there had been a little improvement. Princes street had been lighted up by a few of Bray's lanterns at the corners, and on the line of street by lanterns made by Messrs. Milne and Son, and these lights had a most satisfactory appearance. Princes street, with 32 arc lights upon it, was never half so well lighted as it was with these lamps at the ordinary street distance with two jets in a row, and one of Bray's lights at each corner. Another experiment they had made was with some of Siemens' regenerative burners. They found that with their Scotch gas they could not pass nearly the quantity stated through these burners; but the results obtained were very satisfactory, so much so that they had taken down two electric light pillars, cut 3 feet off them, and placed Siemens burners on the top; and the generally expressed opinion of those who saw the lamps the first night they were in operation was that it was the electric light in a new form. Mr. Sugg had drawn attention to one very important matter, to which gas engineers had not much attended until now—namely, that ventilation must go along with combustion. The plan adopted in the Reading Town Hall was admirable for large halls.

Mr. E. Baker (Reading) said that, being connected with the town of Reading, he naturally took great interest in that part of the paper which referred to the lighting of the Reading Town Hall. It was originally intended that the hall should be lighted by means of electricity; but, as he was asked what he would really recommend, he need scarcely say, as Engineer to the Reading Gas Company, what his answer was. He said, "If you will allow me to consult Mr. Sugg, I have not the slightest doubt we shall be able to get a lighting effect far superior to that which could be obtained from any form of electric lighting." The lighting of the hall had therefore been carried out in the manner which had been described by Mr. Sugg. The burners were so arranged that none of the products of combustion, or of the heat from the gas, found its way into the hall. The lights were placed behind the tinted glass alcove around the building, and in this way they obtained a perfectly diffused light, as little like moonlight and as much like daylight as it could possibly be. On the evening of the opening of the hall the experiment mentioned by Mr. Sugg took place. The gas light was turned on in full daylight at half-past seven, and he could say, with the greatest accuracy, that as the daylight decreased, and the gas took up the lighting, the difference was scarcely perceived. A gentlemen sitting in the hall remarked that it seemed to be a very long evening; and, taking out his watch, said, "Why, it is half-past nine, and it is broad daylight." The inhabitants of Reading thoroughly appreciated the new form of lighting. With regard to the cost (which was, perhaps, the test of the whole thing, and which Mr. Sugg did not mention), it had been very carefully noted, and was found to be 2,500 feet per hour, costing 7s. 3d., or £1 1s. 9d. for the three hours' consumption; and, as Mr. Sugg had said, the illuminating power was equal to 9,000 candles.

Mr. Sugg, in reply, said Mr. Mead had remarked on the power used in producing the electric light at the Crystal Palace. He did not attempt to state the cost of the electric light, because it was such a slippery subject to get hold of. He knew no more than anyone else about its cost; but he knew that, looking at the matter as Mr. Mead had done, from a practical point of view, the same thing was noticed at the Crystal Palace as in Paris. There was an enormous army of engines to do a small amount of lighting. No doubt the effect Mr. Mead noticed with regard to lighting was simply owing to what he had referred to—the small volume of light in proportion to its intensity. With regard to the statement made by Mr. Woodall as to the electric lights going out when they were not wanted to, he might say that he had found one of the lamps at the Crystal Palace, said to be of 3,000-candle power, always did this. Whether it was for friends or for foes, it always seemed to conduct itself in the same manner. He took several visitors to see it, and on every occasion the lamps went out. Mr. Hartley mentioned a fact which was perfectly well known to him (Mr. Sugg), that the electric light was vastly overrated. In making his estimates he had endeavored, as far as he could, to get, not the lowest amount of light that could be obtained, but a fair amount, and to give the greatest amount they would bear. In endeavoring to bring the photometer up to the lights, they danced about so much that an exact observation could not be taken. In moving the photometer it would be necessary to run it backward and forward too rapidly; but when he had it as nearly as he could in the right position, he waited until the lights went up to the standard, and then gave them the most light they would produce at the time. Mr. Mitchell had mentioned the lamps in Edinburgh. He (Mr. Sugg) had seen that splendid piece of electric lighting, and he must say that when the electric lights went out, if it had not been for the street "Arabs" of Edinburgh—who very soon found out the way to restore them, by climbing the pillars and giving them a shake—they would not have recovered themselves for a long time. If it had not been for this circumstance, the lamps would not have produced so good a light as they did. The lights that replaced them were Mr. Bray's, and he (Mr. Sugg) had not had anything to do with it; but he wished to say that the lighting by gas was, as it always had been—whether done by one or the other competitor—vastly superior to anything done by the electric light. He did not, in his tables, give the highest results gas was capable of producing, but he gave an average, always endeavoring rather to understate what gas could do than to overstate it. He thought it safer to err in this way than to follow the lead of the electricians.

[From the London "Journal of Gas Lighting."]

The Present and the Future of the Gas Engine.

One of the usual pamphlets, forming part of the minutes of proceedings of the Institution of Civil Engineers, has been published, containing Mr. Dugald Clerk's paper on the "Theory of the Gas Engine," with an abstract of the discussion thereupon. It is always to be regretted that the Council of the Institution do not allow independent reports of their meetings to reach the public journals, but restrict publication of the proceedings to the official channel. Thus the paper now before us was read on the 4th of April; and although considerable interest was manifested in the subject at the time, it was impossible to obtain a report of the proceedings. One great inconvenience arising from this system may be pointed out—the facility which it affords for the dissemination of the uncorrected opinions of the authors of papers, however false and misleading these may be. Thus the abstract of the paper was distributed by the Institution at the time, and was printed in the *Journal*, and in several other scientific publications, very shortly after it had been read.

Now supposing that Mr. Clerk had committed the gravest blunders in putting his facts together, and that these had been conclusively exposed in the course of the subsequent discussion, not one word of such a correction or refutation could have reached the public, except through the very unsatisfactory medium of correspondence. Or, on the other hand, supposing that a paper read at one of the ordinary meetings has reference to a matter of merely passing interest, on which the expression of the united opinions of the

members of the Institution would be welcomed by the public at large, there is no opportunity of this being made available by the ordinary media of public intercommunication. We would not for a moment be understood to disparage the excellent work done by the official reporter and the Secretary, by whom the minutes of the proceedings are eventually prepared for the press. There is everything to be said in favor of the system of allowing ample time for the discussion of papers, for the revising of speeches, and for the collection of correspondence on any debatable subject. Such a deliberate method of collecting opinions is calculated to ensure the most complete and authoritative expression of opinion; and it might be copied with advantage by other assemblies. But we contend, in addition, for the extension to the periodical press of permission to take and publish abstracts of the *viva voce* discussion of papers at the same time with the papers, in order that the public outside the Institution should not go half satisfied until the authorized report appears some months later. Such a relaxation of the "cast-iron rule" of the Institution would prevent the possible dissemination of error, and would satisfy the public interest in a subject while the matter is still fresh. It would not spoil the effect of the subsequent issue of the authorized excerpt, since the latter would contain details and additional information which would not be published in any periodical. Representations of views of this nature have been repeatedly urged upon the Council, but hitherto in vain. It is almost hopeless to expect a reform in this respect; but we owe it to our readers to explain how it is that, on this occasion, we have been constrained to suspend comment on Mr. Clerk's important paper until so long after the gist of it appeared in these pages.

It will not, we trust, be assumed that the opinion above expressed, with reference to the present facility for the dissemination of false statements by authors of papers read at the Institution, has been formed with reference to Mr. Clerk's paper. It is an opinion based entirely on general grounds, and without reference to any particular example, still less to a communication manifesting so much scientific spirit and so temperately argued as this on the "Theory of the Gas Engine." The paper is designed in the first place to set forth the reasons for the construction of the modern type of powerful gas engines, and to lay down some of the principles upon which their economy depends. It is well known that Mr. Clerk is the inventor of a gas engine which is at the present day the only practically successful rival of the Otto silent gas engines. Both of these engines exist by virtue of avoiding certain errors of theory or construction committed in their predecessors, and Mr. Clerk essays to point out what these were. It will suffice to express the gist of a considerable portion of the paper, if not the whole, by saying that it is a homily, with proofs, of the economy of compression. Mr. Clerk shows that, taking all circumstances into consideration, a gas engine in which the mixture of gas and air is compressed before ignition, is capable of performing three times as much work from the same quantity of gas as an engine which does not use compression. This proposition leads Mr. Clerk into direct conflict of opinion with Mr. Otto and his followers, who have always contended that the economy of the Otto engine is due to the gradual combustion of the weak mixture of gas and air in the cylinder, which is supposed to afford a gradual and expansive pressure. Mr. Clerk, on the contrary, argues that the mixture of gas and air in the modern gas engine is precisely the same as was used in the old Lenoir, which was a direct explosion engine without previous compression, and that the rate of inflammation is even quicker in the modern engine. Consequently the improved result is all due simply to compression, and not to any arrangement for dilution or stratification. The greatest drawback to the economy of the present type of gas engines is the loss of heat through the sides of the cylinder, which requires to be kept cool by a current of water because of one set of considerations, while the necessity of keeping it hot internally is enforced by another set of principles. The result of this conflict is to waste more than one-half of the available power of the gas.

In the course of the discussion of Mr. Clerk's paper, his views respecting the gradual ignition theory of Mr. Otto were warmly combated. It was admitted on both sides that the diagram of the modern economical gas engine shows that pressure is somehow maintained in the closed cylinder throughout the stroke, although the inflammable mixture which, by its combustion, affords this expansive heat and pressure is only ignited momentarily at the commencement of the stroke. Mr. Otto says that this result is due to the fact that the dilute mixture does not all ignite simultaneously, but only by degrees, as the piston moves forward; and thus the development of the heat and pressure, so to speak, is a following one. The author of the paper, as we have already remarked, believes the ignition of all the mixture contained in the cylinder to be instantaneous at the commencement of the stroke. How, then, does he account for the admitted "following" development of heat and pressure? For it is evident that if the gas engine could be regarded, for a moment's illustration, as a hot air engine, and supposing that the hot air could be delivered in the same way as steam to an engine cylinder, at an initial heat and pressure equal to that developed by the instantaneous combustion of the charge of gas and air in the cylinder of the gas engine, then so soon as the piston began to move, the pressure and heat would fall. It is admitted, however, that the heat is maintained beyond the range which hot air in this strictly parallel case would attain. How, therefore, if Mr. Otto's theory of gradual ignition is to be rejected, can this maintenance of heat—which is practically a continuous production of heat—be explained? Mr. Clerk falls back upon the somewhat obscure phenomena of dissociation in order to account for the facts, and uses it in a very ingenious manner. He says that by the instantaneous ignition of the gaseous mixture a degree of temperature is attained beyond that at which dissociation begins. It has been established by M. St. Clair Deville that dissociation of carbonic acid begins at 1000° or 1100° C., and Mr. Clerk states that the highest temperature he has measured in his working cylinder is 1500°C. If both these data are to be relied upon, it follows that there is a certain amount of dissociation in the gaseous contents of the cylinder when the stroke begins. Now the effect of dissociation is only produced at the expense of an amount of heat which is rendered latent by the work of separating the elements of the dissociated gases. Hence the sensible heat of an ignited mixture of gas and air can never be the theoretical maximum, because of the amount of heat borrowed for the work of dissociation, which may begin at 1000°C., and is proportionately increased until the compounds of combustion cannot exist at all. As the temperature falls again, the dissociated gases re-combine, and the latent heat is again rendered sensible and available for other work. Wherefore Mr. Clerk says that, although the explosive mixture in his own and the Otto engines is ignited instantaneously at the beginning of the stroke, some of the products are immediately dissociated in consequence of the extreme heat developed, and that it is the subsequent re-combination of these elements which sets free the additional heat that is maintained throughout the stroke of the engine. Mr. Clerk, in short, says that the continuous development of heat in the engine is due to the effect of cooling from the previous excessive temperature; while Mr. Otto denies that such excessive temperature, or its attendant dissociation, occurs at all, and that the simple idea of slow combustion of the charge better explains the phenomenon.

It has been no slight task to disentangle the arguments of the two contending parties, and present them in the above simple form. It is not for us to incline to the one side or the other in this abstruse controversy, especially as the principal value of the distinction sought for appears to be in connection with the question of patent right. It may be remarked, however, that the velocity of propagation of a wave of explosion through a gaseous mixture is, by recent researches of MM. Mallard and Le Chatelier and MM. Berthelot and Vielle, shown to be so great that it is difficult to believe Mr. Otto's theory, which requires an appreciable time for the spread of ignition through a very small bulk of charge. Still, it must be confessed that Mr. Clerk has to make one or two crucial tests before his theory will meet with general acceptance.

It is impossible to peruse the paper and the discussion without feeling very strongly the force of Dr. Siemens's remark, that the gas engine is at present in the condition of the steam engine in the days of Newcomen. It is well known that in the early steam engines of that era, after sufficient steam had been admitted to raise the piston, a jet of cold water was thrown into the cylinder to condense it and cause a vacuum. It is evident that the practice of circulating cold water around the outside of a gas engine cylinder is not a great advance upon this primitive device. Yet so long as the designers of gas engines remain content to admit that the gas which they use gives them more heat than they are able to turn into power, so that they are compelled to waste half of it through the sides of the cylinder, it is difficult to see how this practice of keeping the cylinder cool can be superseded. It is admitted, however, by the author, that in the large gas engines of the future, if machines of this class are to supersede or rival steam engines, the cold cylinder must be dispensed with, and some suitable form of hot cylinder be applied in its stead. At present there is no hot cylinder gas engine in existence which can be regarded as completely solving the practical and theoretical problems such as are only partly satisfied by the cold cylinder engines, working with compression. The gas engine is already "differentiated" in two kinds. There is the simple explosive engine of the "Bisschop" order, which does not compress its charge, and is only economical in comparison with small power below the range of applicability of the usual working sizes of steam engines. And, besides this, there is the horizontal engine of the Otto and Clerk types, which compresses its charge, and competes with the steam engine in economy of working up to about 50-horse power. Yet it is admitted that the possibility of competition does not arise from the comparative economy of the gas engine as a machine for turning heat into power, but merely because it does not require so much attention as, and is more convenient in many respects than its rival.

On a strict comparison of fuel, the steam engine has an enormous advantage, and it is necessary to survey the possibility of reducing this advantage before deciding as to whether it will be possible for any class of gas engines to work on equal terms with the steam engine upon the largest scale.

The adequate discussion of this question cannot be attempted in one short

article, or near the close of a notice of a totally different subject; but it may be taken that Mr. Clerk has indicated in few words the first necessity of its solution. Could the extravagant dissipation of heat through the side of a gas engine cylinder be prevented, we should reduce the consumption of gas per horse power by at least one-half. At a time when mechanical engineers are jacketing steam cylinders, and using "hot pots" and other devices for retaining the heat of steam in the working part of the engine, how illogical it seems that gas engines are treated in an entirely different way! We may not be able to prevent some waste of heat; but perfection will not be even within a measurable distance until at least as much care is taken of the heat of a gas engine cylinder as now of a steam cylinder. This would bring the consumption of gas per indicated horse power per hour down to about ten cubic feet of the common quality, costing perhaps one-third of a penny as delivered from the mains of a gas company. But taking Mr. Cowper's estimate of the cost of fuel for a good steam engine at one-tenth of a penny per hour, there is yet a considerable difference to be compensated in some way. Adding the cost of labor, insurance, and other expenses to the latter estimate will barely double the figure; but assuming that two-tenths of a penny per hour represents the cost of steam horse power, the cost of a gas engine to compete with this is soon found.

Supposing that a gas engine, as efficient in all respects as a steam engine, will work on ten cubic feet of commercial coal gas, or fifty cubic feet of generator gas, per horse power per hour, this rate of consumption must be supplied with gas costing rather less than two shillings per 1000 cubic feet and five pence per 1000 cubic feet, respectively, for the two kinds of gas. Pursuing this comparison of cost a little further, it will be observed that coal gas is not now sold anywhere at a price which will enable the existing types of gas engine to compete, on fuel account, with steam engines of a high class; since as the gas engines consume more than twice as much gas as they ought, the fuel should be worth less than one shilling per 1000 cubic feet in order to preserve the equilibrium.

It is satisfactory, however, to be assured that the conditions of the economical problem are so well marked, and also, it may be said, not hopeless of eventual fulfillment in practice. Mechanical engineers have but to improve the heat economizing arrangements of the gas engine up to the level of the existing types of steam engines, in order to reduce the consumption of gas by one-half, or perhaps more. When this shall be done, steam engines will disappear wherever a supply of common coal gas can be obtained at about 2 shillings per thousand cubic feet; and at the same time an improved gas generator may be expected to take the place of the steam boiler in places where the stronger retort gas cannot be obtained.

Meanwhile, and until the mechanicians have completed their part of the work, the duty of gas manufacturers is plain—it is simply to take advantage of every means for the cheapening of gas to the public. When this is done, the designer of gas engines will be assured, not only of the active co-operation of the gas manufacturer, but of a welcome from the consumer, who, by previous experience of liberal treatment, will be encouraged to support the company or corporation that combine their interests with his own.

Address of Dr. C. W. Siemens before the British Association for the Advancement of Science.

The Fifty-second Meeting of the British Association for the Advancement of Science was held in Southampton, commencing August 23d, and lasting for several days. On the evening of Wednesday, August 23d, Dr. C. W. Siemens, the President, delivered his inaugural address, from which we take the following—

The largest and most extensive application of electric energy at the present time is to lighting; but considering how much has of late been said and written for and against this new illuminant, I shall here confine myself to a few general remarks. Joule has shown that if an electric current is passed through a conductor, the whole of the energy lost by the current is converted into heat; or, if the resistance be localized, into radiant energy comprising heat, light, and actinic rays. Neither the low heat rays nor the ultra violet of highest refrangibility affect the retina, and may be regarded as lost energy; the effective rays being those between the violet and red of the spectrum, which in their combination produce the effect of white light. Regarding the proportion of luminous to non-luminous rays proceeding from an electric arc or incandescent wire, we have a most valuable investigation by Dr. Tyndall, recorded in his work on "Radiant Heat." Dr. Tyndall shows that the luminous rays from a platinum wire heated to its highest point of incandescence, which may be taken at 1700°C., formed 1-24th part of the total radiant energy emitted, and one-tenth part in the case of an arc light worked by a battery of 50 Grove's elements.

In order to apply these data to the case of electric lighting by means of dynamo currents, it is necessary in the first place to determine what is the power of 50 Grove's elements of the size used by Dr. Tyndall, expressed in the practical scale of units as now established. From a few experiments lately undertaken for myself, it would appear that 50 such cells have an electro-motive force of 98.5 volts, and an internal resistance of 13.5 ohms, giving a current of 7.3 amperes when the cells are short-circuited. The resistance of a regulator such as Dr. Tyndall used in his experiments may be taken at 10 ohms; the current produced in the arc would be $\frac{98.5}{13.5+10+1}=$ 4 amperes (allowing 1 ohm for the leads), and the power consumed $10\times4^2=$ 160 watts. The light power of such an arc would be about 150 candles; and comparing this with an arc of 3308 candles produced by 1162 watts, we find that $\frac{1162}{160}$, *i.e.*, 7.3 times the electric energy produce $\frac{3308}{150}$, *i.e.*, 22 times the amount of light measured horizontally. If, in Dr. Tyndall's arc, 1-10th of the radiant energy emitted was visible as light, it follows that in a powerful arc of 3300 candles, $\frac{1}{10}\times\frac{22.0}{7.3}$, or fully one-third, are luminous rays. In the case of the incandescent light (say a Swan light of 20 candle power) we find in practice that nine times as much power has to be expended as in the case of the arc light; hence 1-27th part of the power is given out as luminous rays, as against 1-24th in Dr. Tyndall's incandescent platinum—a result sufficiently approximate considering the wide difference of conditions under which the two are compared. These results are not only of obvious practical value, but they seem to establish a fixed relation between current, temperature and light produced, which may serve as a means to determine temperatures exceeding the melting point of platinum with greater accuracy than has hitherto been possible by actinimetric methods, in which the thickness of the luminous atmosphere must necessarily exercise a disturbing influence. It is probably owing to this circumstance that the temperature of the electric arc as well as that of the solar photosphere has frequently been greatly over-estimated.

The principal argument in favor of the electric light is furnished by its immunity from products of combustion, which not only heat the lighted apartments, but substitute carbonic acid and deletericus sulphur compounds for the oxygen upon which respiration depends. The electric light is white instead of yellow, and thus enables us to see pictures, furniture, and flowers as by daylight; it supports growing plants instead of poisoning them, and by its means we can carry on photography and many other industries at night as well as during the day. The objection frequently urged against the electric light, that it depends upon the continuous motion of steam or gas engines, which are liable to accidental stoppage, has been removed by the introduction into practical use of the secondary battery. This, although not embodying a new conception, has lately been greatly improved—in power and constancy—by Plante, Faure, Volckmar, Sellon and others, and promises to accomplish for electricity what the gasholder has done for the supply of gas, and the accumulator for hydraulic transmission of power. It can no longer be a matter of reasonable doubt, therefore, that electric lighting will take its place as a public illuminant, and that, even though its cost should be found greater than that of gas, it will be preferred for the lighting of drawing-rooms and dining-rooms, theaters and concert-rooms, museums, churches, warehouses, showrooms, printing establishments, and factories, and also the cabins and engine-rooms of passenger steamers. In the cheaper and more powerful form of the arc light it has proved itself superior to any other illuminant for spreading artificial light over the large areas of harbors, railway stations, and the sites of public works. When placed within a holophote the electric lamp has already become a powerful auxiliary in effecting military operations both by sea and land. The electric light may be worked by natural sources of power, such as waterfalls, the tidal wave, or the wind; and it is conceivable that these may be utilized at considerable distances by means of metallic conductors. Some five years ago I called attention to the vastness of these sources of energy, and the facility offered by electrical conductors in rendering them available for lighting and power supply; while Sir William Thomson made this important matter the subject of his admirable address to Section A last year at York, and dealt with it in an exhaustive manner.

The advantages of the electric light and of the distribution of power by electricity have lately been recognized by the British Government, who have just passed a Bill through Parliament to facilitate the establishment of electrical conductors in towns, subject to certain regulating clauses to protect the interests of the public and of local authorities. Assuming the cost of electric light to be practically the same as gas, the preference for one or the other will in each application be decided upon grounds of relative convenience; but I venture to think that gas will hold its own as the poor man's friend. Gas is an institution of the utmost value to the artizan; it hardly requires any attention, is supplied upon regulated terms, and gives with it what should be a cheerful light as well as a genial warmth, which often saves the lighting of a fire. The time is, moreover, not far distant, I venture

to think, when both rich and poor will largely resort to gas as the most convenient, the cleanest, and the cheapest of heating agents, and when raw coal will be seen only at the colliery or the gas works. In all cases where the town to be supplied is within (say) 30 miles of the colliery, the gas works may with advantage be placed at the mouth, or still better at bottom of the pit, whereby all haulage of fuel would be avoided, and the gas, in its ascent from the bottom of the colliery, would acquire an onward pressure sufficient probably to impel it to its destination. The possibility of transporting combustible gas through pipes for such a distance has been proved at Pittsburg, where natural gas from the oil district is used in large quantities.

The *quasi* monopoly so long enjoyed by gas companies has had the inevitable effect of checking progress. The gas being supplied by meter, it has been seemingly to the advantage of the companies to give merely the prescribed illuminating power, and to discourage the invention of economical burners in order that the consumption might reach a maximum. The application of gas for heating purposes has not been encouraged, and is still made difficult in consequence of the objectionable practice of reducing the pressure in the mains during the daytime to the lowest possible point consistent with prevention of atmospheric in-draught. The introduction of the electric light has convinced gas managers and directors that such a policy is no longer tenable, but must give way to one of technical progress. New processes for cheapening the production and increasing the purity and illuminating power of gas are being fully discussed before The Gas Institute; and improved burners, rivalling the electric light in brilliancy, greet our eyes as we pass along our principal thoroughfares.

Regarding the importance of the gas supply as it exists at present, we find from a Government return that the capital invested in gas works in England, other than those of local authorities, amounts to £30,000,000. In these, 4,281,048 tons of coal are converted annually, producing 43,000 million cubic feet of gas, and about 2,800,000 tons of coke; wherens the total amount of coal annually converted in the United Kingdom may be estimated at nine millions of tons, and the bye-products therefrom at 500,000 tons of tar, one million tons of ammoniacal liquor, and four millions tons of coke, according to the returns kindly furnished me by the managers of many of the gas works and corporations. To these may be added (say) 120,000 tons of sulphur, which up to the present time is a waste product.

Previous to the year 1856—that is to say, before Mr. W. H. Perkin had invented his practical process, based chiefly upon the theoretical investigations of Hofmann, regarding the coal tar bases and the chemical constituents of indigo—the value of coal tar in London was scarcely one-halfpenny a gallon, and in country places gas makers were glad to give it away. Up to that time the coal tar industry had chiefly consisted in separating the tar by distillation into naphtha, creosote, oils and pitch. A few distillers, however, made small quantities of benzine, which had been first shown—by Mansfield, in 1849, to exist in coal tar naphtha mixed with toluene, cumene, etc. The discovery, in 1856, of the mauve or aniline purple gave a great impetus to the coal tar trade, inasmuch as it necessitated the separation of large quantities of benzine, or a mixture of benzine and toluene, from the naphtha. The trade was further increased by the discovery of the magenta or rosaniline dye, which required the same products for its preparation. In the meantime carbolic acid was gradually introduced into commerce, chiefly as a disinfectant, but also for the production of coloring matter.

The next most important development arose from the discovery by Graebe and Liebermann that alizarine, the coloring principle of the madder root, was allied to anthracene, a hydrocarbon existing in coal tar. The production of this coloring matter from anthracene followed, and is now one of the most important operations connected with tar distilling. The success of the alizarine made in this manner has been so great that it has almost entirely superseded the use of madder, which is now cultivated to only a comparatively small extent. The most important coloring matters lately introduced are the azo-scarlets. They have called into use the coal tar hydrocarbons xylene and cumene. Naphthaline is also used in their preparation. These splendid dyes have replaced cochineal in many of its applications, and have thus seriously interfered with its use. The discovery of artificial indigo by Prof. Baeyer is of great interest. For the preparation of this coloring matter toluene is required.

The color industry utilizes even at the present time practically all the benzene, a large proportion of the solvent naphtha, all the anthracene, and a portion of the naphthaline resulting from the distillation of coal tar; and the value of the coloring matter thus produced is estimated by Mr. Perkin at £3,350,000. The demand for ammonia may be taken as unlimited, on account of its high agricultural value as a manure; and, considering the failing supply of guano and the growing necessity for stimulating the fertility of our soil, an increased production of ammonia may be regarded as a matter of national importance, for the supply of which we have to look almost exclusively to our gas works. The present production of 1,000,000 tons of ammoniacal liquor yields 95,000 tons of sulphate of ammonia, which, taken at £20 10s. a ton, represents an annual value of £1,947,000.

The total annual value of the gas works bye-products may be estimated as follows:

Coloring matter	£3,350,000
Sulphate of ammonia	1,947,000
Pitch (325,000 tons)	365,000
Creosote (25,000,000 gallons)	208,000
Crude carbolic acid (1,000,000 tons)	100,000
Gas coke, 4,000,000 tons (after allowing 2,000,000 tons consumption in working the retorts), at 12s	2,400,000
Total	£8,370,000

Taking the coal used (9,000,000 tons) at 12s. per ton, equal £5,400,000, it follows that the bye-products exceed in value the coal used by very nearly £3,000,000.

In using raw coal for heating purposes these valuable products are not only absolutely lost to us, but in their stead we are favored with those semi-gaseous bye-products in the atmosphere too well known to the denizens of London and other large towns as smoke. Professor Roberts has calculated that the soot in the pall hanging over London on a winter's day amounts to 50 tons, and that the carbonic oxide—a poisonous compound resulting from the imperfect combustion of coal—may be taken as at least five times that amount. Mr. Aitken has shown, moreover, in an interesting paper communicated to the Royal Society of Edinburgh last year, that the fine dust resulting from the imperfect combustion of coal is mainly instrumental in the formation of fog, each partical of solid matter attracting to itself aqueous vapor. These globules of fog are rendered particularly tenacious and disagreeable by the presence of tar vapor—another result of the imperfect combustion of raw fuel, which might be turned to much better account at the dye works. The hurtful influence of smoke upon public health, the great personal discomfort to which it gives rise, and the vast expense it indirectly causes through the destruction of our monuments, pictures, furniture, and apparel, are now being recognized, as evinced by the success of recent smoke abatement exhibitions.

The most effectual remedy would result from a general recognition of the fact that wherever smoke is produced fuel is being consumed wastefully, and that all our calorific effects, from the largest down to the domestic fire, can be realized as completely, and more economically, without allowing any of the fuel employed to reach the atmosphere unburnt. This most desirable result may be effected by the use of gas for all heating purposes, with or without the addition of coke or anthracite. The cheapest form of gas is that obtained through the entire distillation of fuel in such gas producers as are now largely used in working the furnaces of glass, iron, and steel works; but gas of this description would not be available for the supply of towns, owing to its bulk, about two-thirds of its volume being nitrogen. The use of water gas, resulting from the decomposition of steam in passing through a hot chamber filled with coke, has been suggested; but this gas also is objectionable, because it contains, besides hydrogen, the poisonous and inodorous gas, carbonic oxide, the introduction of which into dwelling houses could not be effected without considerable danger.

A more satisfactory mode of supplying heating separately from illuminating gas would consist in connecting the retort at different periods of the distillation with two separate systems of mains for the delivery of the respective gases. Experiments made some years ago by M. Ellissen, of the Paris Gas Works, have shown that the gases rich in carbon, such as olefiant and acetylene, are developed chiefly during an interval of time beginning half an hour after the commencement and terminating at half the whole period of distillation; whilst during the remainder of the time marsh gas and hydrogen are chiefly developed, which, while possessing little illuminating power, are most advantageous for heating purposes. By resorting to improved means of heating the retorts with gaseous fuel, such as have been in use at the Paris Gas Works for a considerable number of years, the length of time for effecting each distillation may be shortened from six hours—the usual period in former years—to four, or even three hours, as now practiced at Glasgow and elsewhere. By this means a given number of retorts can be made to produce, besides the former quantity of illuminating gas of superior quality, a similar quantity of heating gas, resulting in a diminished cost of production and an increased supply of the valuable bye-products previously referred to.

The quantity both of ammonia as well as of the heating gas may be further increased by the simple expedient of passing a streamlet of steam through the heated retorts towards the end of each operation, whereby the ammonia and hydrocarbons still occluded in the heated coke will be evolved, and the volume of heating gas produced be augmented by the products of decomposition of the steam itself. It has been shown that gas may be used advantageously for domestic purposes, with judicious management, even under present conditions; and it is easy to see that its consumption for heating would soon increase, perhaps tenfold, if supplied separately at say 1s. per

1000 cubic feet. At this price gas would not only be the cleanest and most convenient, but also the cheapest form of fuel, and the enormous increase of consumption, the superior quality of the illuminating gas obtained by selection, and the proportionate increase of bye-products, would amply compensate the gas company or corporation for the comparatively low price of the heating gas.

The greater efficiency of gas as a fuel results chiefly from the circumstance that one pound of gas yields in combustion 22,000 heat units, or exactly double the heat produced in the combustion of one pound of ordinary coal. This extra heating power is due partly to the freedom of the gas from earthy constituents, but chiefly to the heat imparted to it in effecting its distillation.

Recent experiments with gas burners have shown that in this direction also there is much room for improvement. The amount of light given out by a gas flame depends upon the temperature to which the particles of solid carbon in the flame are raised; and Dr. Tyndall has shown that of the radiant energy set up in such a flame, only the 1-25th part is luminous. The hot products of combustion carry off at least four times as much energy as is radiated, so that not more than 100th part of the heat evolved in combustion is converted into light. This proportion could be improved, however, by increasing the temperature of combustion, which may be effected either by intensified air currents or by regenerative action. Supposing that the heat of the products of combustion could be communicated to metallic surfaces, and be transferred by conduction or otherwise to the atmospheric air supporting combustion in the flame, we should be able to increase the temperature accumulatively to any point within the limit of dissociation. This limit may be fixed at about 2300°C., and cannot be very much below that of the electric arc. At such a temperature the proportion of luminous rays to the total heat produced in combustion would be more than doubled, and the brilliancy of the light would at the same time be greatly increased. Thus improved gas lighting may continue its rivalry with electric lighting both as regards brilliancy and economy, and such rivalry must necessarily result in great public advantage.

In the domestic grate, radiant energy of inferior intensity is required; and I, for one, do not agree with those who would like to see the open fireplace of this country superséded by the Continental stove. The advantages usually claimed for the open fireplace are, that it is cheerful, "pokable," and conducive to ventilation; but to these may be added another, of even greater importance—viz., that the radiant heat which it emits passes through the transparent air without warming it, and imparts heat only to the solid walls, floor, and furniture of the room, which are thus constituted the heating surfaces of the comparatively cool air of the apartments in contact with them.

In the case of stoves, the heated air of the room causes deposit of moisture upon the walls in heating them, and gives rise to mildew and germs injurious to health. It is, I think, owing to this circumstance that upon entering an apartment one can immediately perceive whether or not it is heated by an open fireplace; nor is the unpleasant sensation due to stove heating completely removed by mechanical ventilation. There is, moreover, no good reason why an open fireplace should not be made as economical and smokeless as a stove or hot water apparatus.

In the production of mechanical effect from heat, gaseous fuel also presents most striking advantages, as will appear from the following consideration. When we have to deal with the question of converting mechanical into electrical effect, or *vice versa*, by means of the dynamo electrical machines, we have only to consider what are the equivalent values of the two forms of energy, and what precautions are necessary to avoid losses by the electrical resistance of conductors and by friction. The transformation of mechanical effect into heat involves no losses except those resulting from imperfect installation; and these may be so completely avoided, that Dr. Joule was able to determine by this method the equivalent values of the two forms of energy. But in attempting the inverse operation of effecting the conversion of heat into mechanical energy, we find ourselves confronted by the second law of thermo-dynamics, which says that whenever a given amount of heat is converted into mechanical effect, another but variable amount descends from a higher to a lower potential, and is thus rendered unavailable. In the condensing steam engine this waste heat comprises that communicated to the condensing water, while the useful heat, or that converted into mechanical effect, depends upon the difference of temperature between the boiler and condenser. The boiler pressure is limited, however, by considerations of safety and convenience of construction, and the range of working temperature rarely exceeds 120°C., except in the engines constructed by Mr. Perkins, in which a range of 160°C., or an expansive action commencing at 14 atmospheres, has been adopted with considerable promise of success, as appears from an able report on this engine by Sir Frederick Bramwell.

To obtain more advantageous primary conditions, we have to turn to the caloric or gas engine, because in them the co-efficient of efficiency expressed by $\frac{T-T'}{T}$ may be greatly increased. This value would reach a maximum if the initial absolute temperature T could be raised to that of combustion, and T′ reduced to atmospheric temperature, and these maximum limits can be much more nearly approached in the gas engine, worked by a combustible mixture of air and hydrocarbons than in the steam engine.

Assuming, then, in an explosive gas engine a temperature of 1500°C. at a pressure of four atmospheres, we should, in accordance with the second law of thermo-dynamics, find a temperature after expansion to atmospheric pressure of 600°C., and therefore a working range of 1500°—600°=900°, and a theoretical efficiency $\frac{900}{1500+274}$=about one-half, contrasting very favorably with that of a good expansive condensing steam engine, in which the range is 150—30=120°C., and the efficiency $\frac{120}{150+274}=\frac{2}{7}$. A good expansive steam engine is therefore capable of yielding as mechanical work two-sevenths part of the heat communicated to the boiler, which does not include the heat lost by imperfect combustion, and that carried away in the chimney. Adding to these, the losses by friction and radiation in the engine, we find that the best steam engine yet constructed does not yield in mechanical effect more than one-seventh part of the heat energy residing in the fuel consumed. In the gas engine we have also to make reductions from the theoretical efficiency, on account of the rather serious loss of heat by absorption into the working cylinder, which has to be cooled artificially in order to keep its temperature down to a point at which lubrication is possible; this, together with frictional loss, cannot be taken at less than one-half, and reduces the factor of efficiency of the engine to one-fourth.

It follows from these considerations that the gas or caloric engine combines the conditions most favorable to the attainment of maximum results, and it may reasonably be supposed that the difficulties still in the way of their application on a large scale will gradually be removed. Before many years have elapsed we may find in our factories and on board our ships engines with a fuel consumption not exceeding one pound of coal per effective horse power per hour, in which the gas-producer takes the place of the somewhat complex and dangerous steam boiler. The advent of such an engine and of the dynamo machine must mark a new era of material progress at least equal to that produced by the introduction of steam power in the early part of our century.

Waterproof Cement.

Herr C. Puscher, of Prussia, has published an account of a number of experiments made by him with the object of rendering cement manufactures and lime plaster proof against the effects of the weather. He states that a cold solution of one part of green copperas in three parts of water is extremely effective.

Cement manufactures are put into the solution for twenty-four hours, and then, colored greenish black by the oxidulated iron hydrate which has been formed, dried in the air. The absorbed solution of copperas has been decomposed in the cement, and the combination of hydrated peroxide of iron formed is stated not only to render the cement denser and harder, but also, as it is not affected by the weather, to impart to it greater resistance. The weight of the cement is increased by ten per cent., without any change in form. It would be interesting to learn whether the favorable opinion of Herr Puscher is confirmed by other experimenters. Cement plaster is protected against the effects of the weather by repeated applications of the copperas solution. If, after the fourth application, the cement does not turn a dark greenish-black, it is a sign that the surface has become saturated with the iron combination. After drying, a coating is formed on the cement of an ochre-like color, which cannot be washed off with water, and which will take water colors.

If cement plaster thus prepared is to be permanently painted with oil colors—which, as is well known, peel off ordinary cement—two applications of five per cent. soap water are sufficient to render it waterproof, and, after drying and rubbing with a cloth, as shiny as oil color, so that one coating of the latter may be saved. In order to protect cement manufactures prepared with copperas against alkalies, acids, and the influence of the weather, a layer penetrating a few centimeters, of a heated mixture of equal parts of ordinary paraffine oil, or petroleum, is sufficient, which is obtained by immersing the heated cement articles in it for a few minutes.

This cheap copperas solution may also be used for old or new lime plaster; old lime plaster must, however, first be freed from loose particles of color by washing off. It is not advisable to mix the cement and sand at once with the copperas solution, as cement thus prepared cracks after drying.

Chicago is to have a new gas light company, work upon which is to begin soon.

THE AMERICAN
GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

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Manager—C. E. SANDERSON.

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SATURDAY, SEPTEMBER 16, 1882.

New Researches in the Propagation of Explosive Phenomena in Gases.

The speed of translation of the gaseous molecules preserving the totality of the *vis viva* which corresponds to the heat liberated by the reaction, may be regarded as a limit representing the maximum speed of propagation of the explosive wave. But this speed is diminished by contact with gases and other foreign bodies, and equally so when the gas ignited is too small, and is too rapidly cooled by radiation, and also when the elementary speed of the chemical reaction is too feeble, as may happen with carbonic oxide. In these conditions there is a retardation of the wave, and it may even cease to reproduce itself, the combustion then propagating itself according to a much slower law. —*Comptes Rendus.*

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
(with W B Scott & Co.,)
34 PINE STREET, NEW YORK CITY.

SEPTEMBER 16, 1882.

☞ All communciations will receive particular attention
☞ The following quotations are based on the par value of $100 per share. ☜

Gas Co.'s of N. Y. City.

	Capital.	*Par.*	*Bid.*	*Asked*
Central	$466,000	50	75	85
Harlem	1,800,000	50	97	1 0x
" Bonds	170,000			103
Manhattan	4,000,000	50	222	224
Metropolitan	2,500,000	100	177	180x
" Bonds	658,000		107	110
Mutual	5,000,000	100	98	102
" Bonds, go'd.	900,000	1000	100	104
Municipal	1,500,000	100	185	190
" Bonds	750,000		106	110
New York	4,000,000	100	117	120
Northern	270,000	50	—	100
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	107	112
Citizens	1,200,000	20	68	70
" S. F. Bonds.	320,000	1000	105	107
Fulton Municipal	3,600,000	100	75	80
Peoples	1,000,000	10	40	45
" Bonds	290,000	.	104	107
" "	250,000	...	78	90
Metropolitan	1,000,000	100	68	70
Nassau	1,000,000	25	50	55
" Ctfs.	700,000	1000	93	96
Williamsburgh	1,000,000	50	57	60
" Bonds	1,000,000	...	100	101
Richmond Co., S. I.	300,000	50	70	75
" Bonds	40,000	—	—	—
Out of Town Gas Companies.				
Buffalo Mutual, N.Y	750,000	100	—	75
" Bonds	200,000	1000	95	100
Citizens, Newark	918,000	50	—	—
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			125	—
Cincinnati G. & C. Co.			178	180
Consolidated, Balt.			42	43
Bonds			107	—
East Boston, Mass	220,000	25	122	128
Hannibal, Mo.	100,000	100	95	100
Hartford, Conn.	700,000	25	140	144
Halifax N. S.	400,000	40	148	150
Hamilton, Ontario	150,000	40	117½	
Jersey City	750,000	20	155	160
Jacksonville, Ill.	120,000	50	100	...
Lewistown Maine	400,000	100	—	100
Laclede St Louis Mo.	1,200,000	100	117	—
Montreal, Canada	2,000,000	100	168	170
New Haven, Conn		25	132	—
Oakland, Cal.			32	33
Peoples, Jersey City		...	75	80
" " Bds.			...	...
Pittsfield, Mass.			120	130
Rochester, N. Y.		50	70	80
Wilmington, Del.		50	174	...
Yonkers		50	30	32
St. Louis Missouri	600,000	50	250	254
San Francisco Gas-Co., S. Fr'isco Cal.			68	69
Toledo, Ohio			95	97
Troy, Citizens	600,000	100	—	—
Washington, D. C.	1,500,000	20	185	200
" Scrip	375,000	15	200	206

Sold at auction: $5500 Metropolitan 6 p.c. bonds, due 1901, at 106½; $1000 Williamsburgh bds., at 97½.

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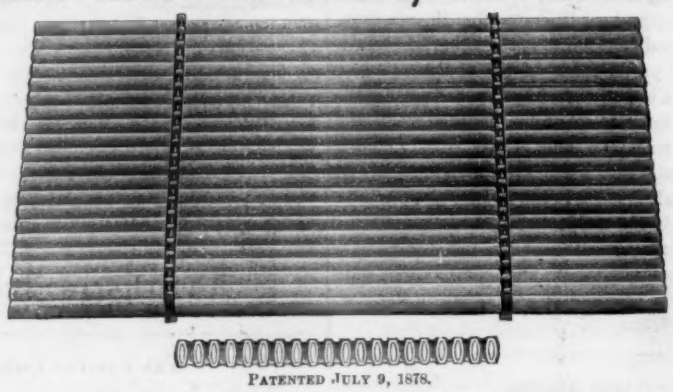

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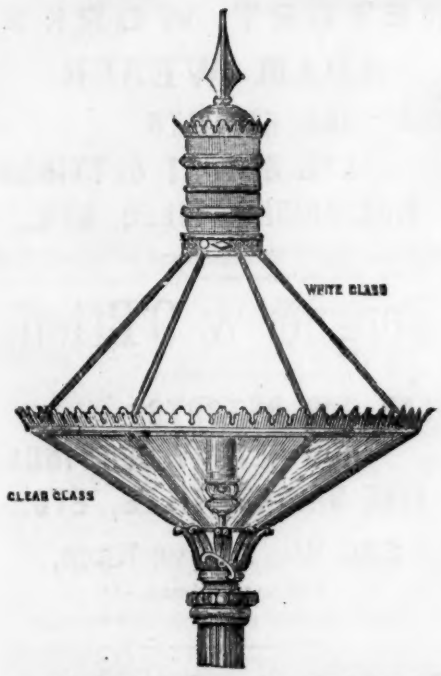

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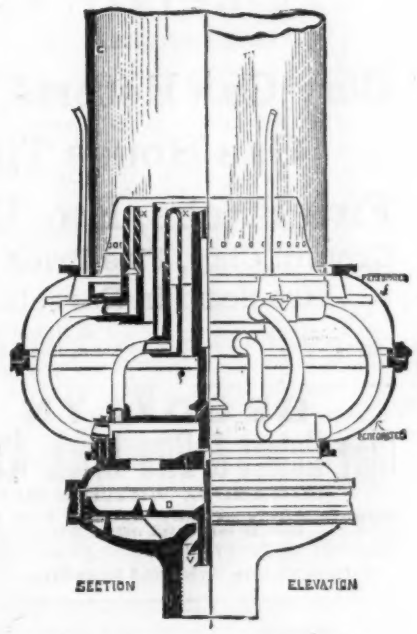
Size.	Candles.	Size.	Candles.
A (15 holes)	10	HH (36 holes)	29½
B (18 ")	12	J (38 ")	29
C (21 ")	14	JJ (38 ")	30½
D (24 ")	16	K (42 ")	31
E (27 ")	18	KK (42 ")	34
F (30 ")	20	NN (75 " 2 rings)	50
G (33 ")	24	100 Candles (2 rings)	100
GG (33 ")	25½	200 " (3 ")	200
H (36 ")	28	400 " (4 ")	400



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Size.	Price.	Size.	Price.
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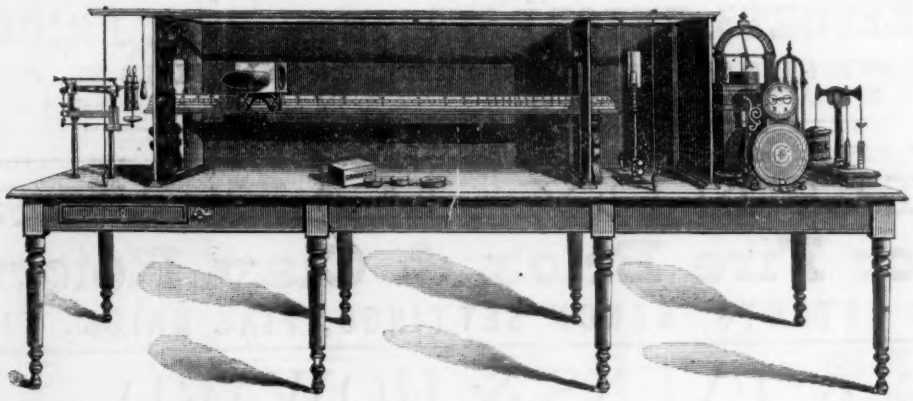

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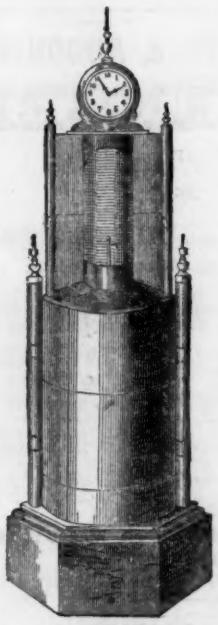

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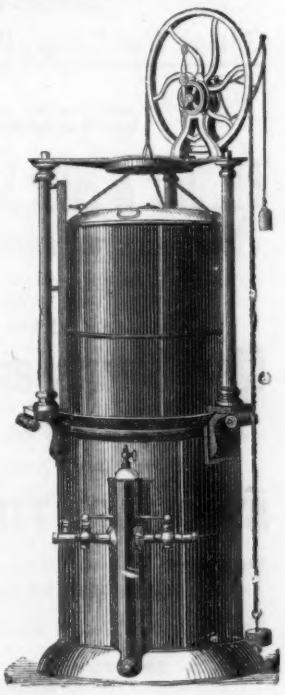

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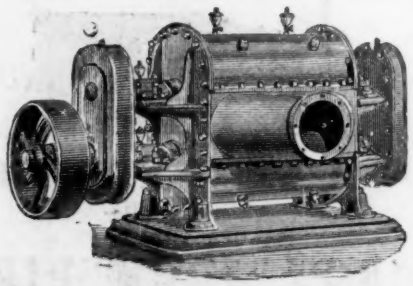

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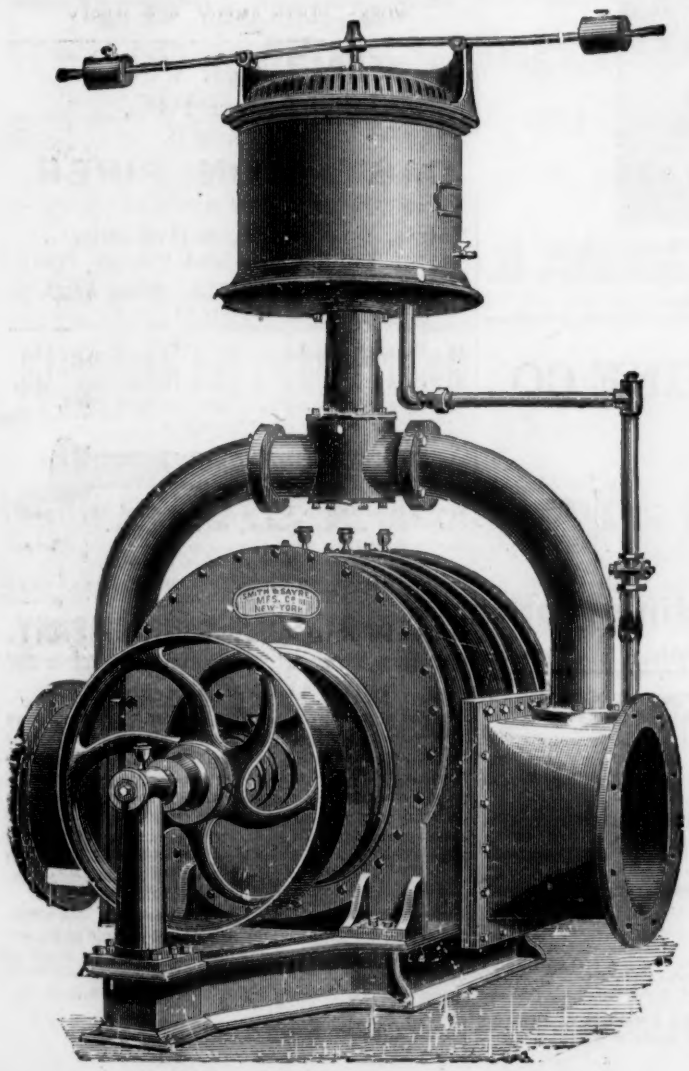

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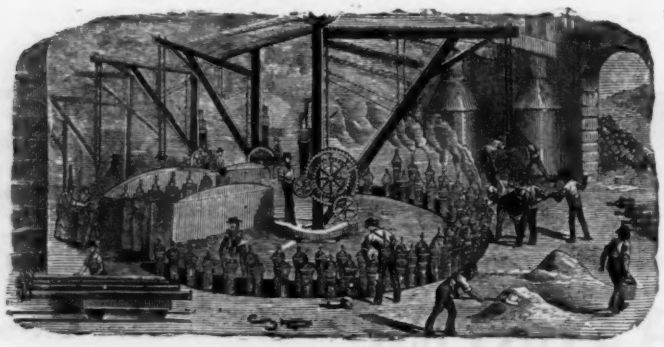

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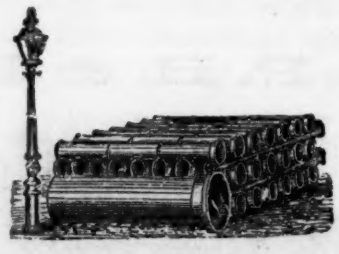

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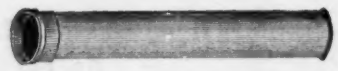

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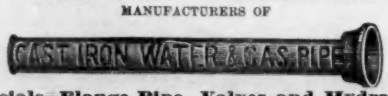

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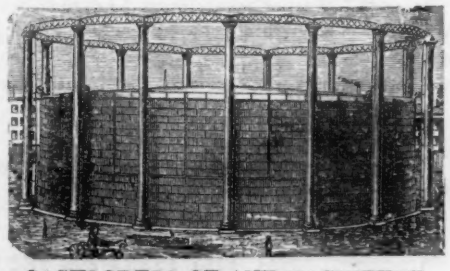

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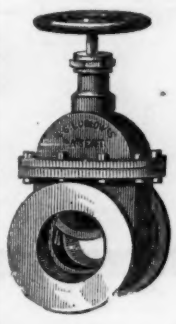

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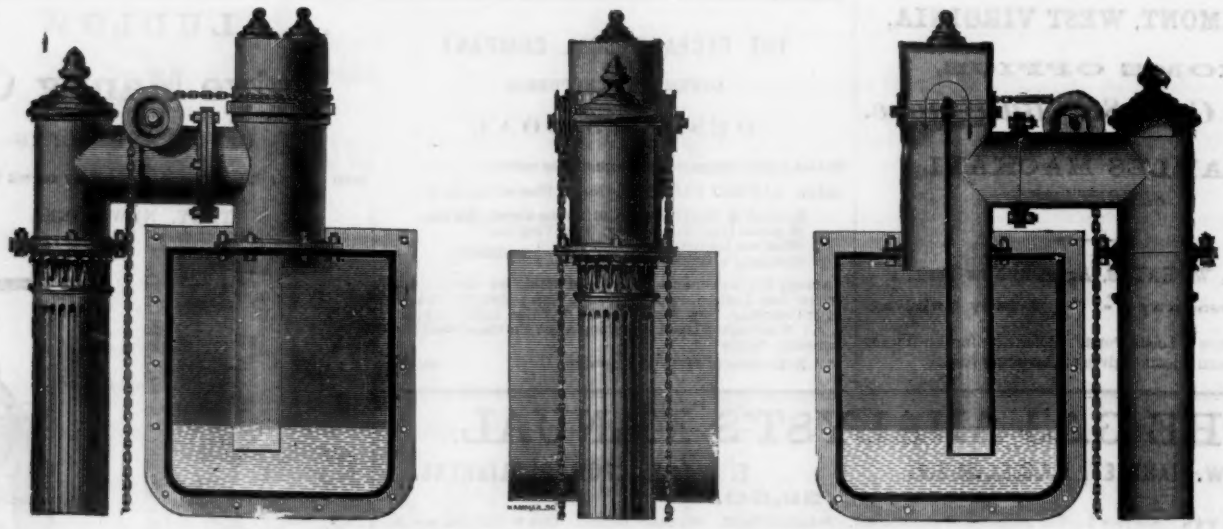

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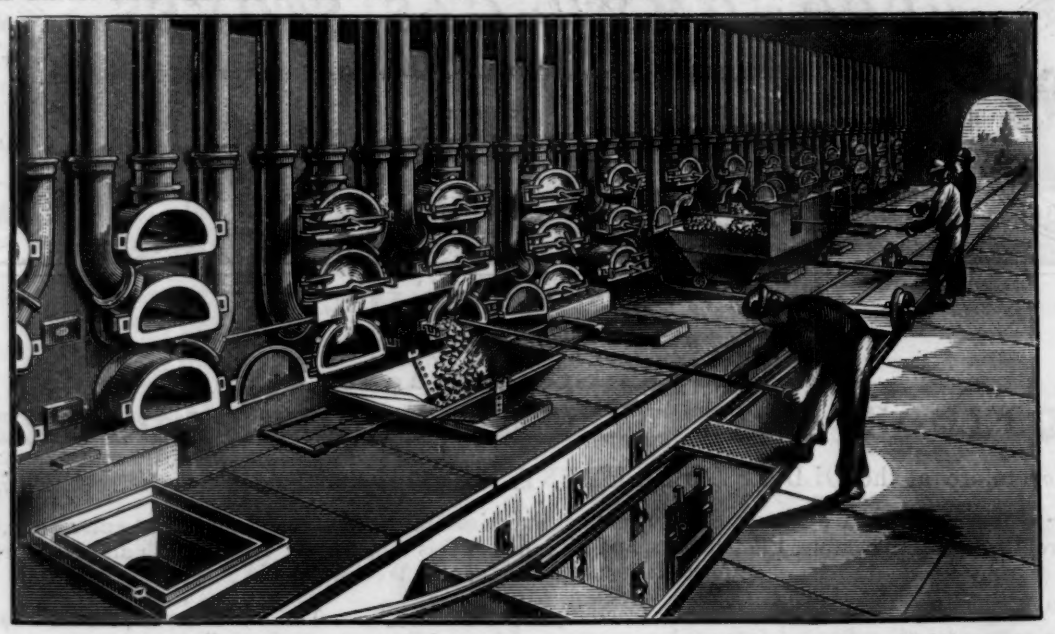

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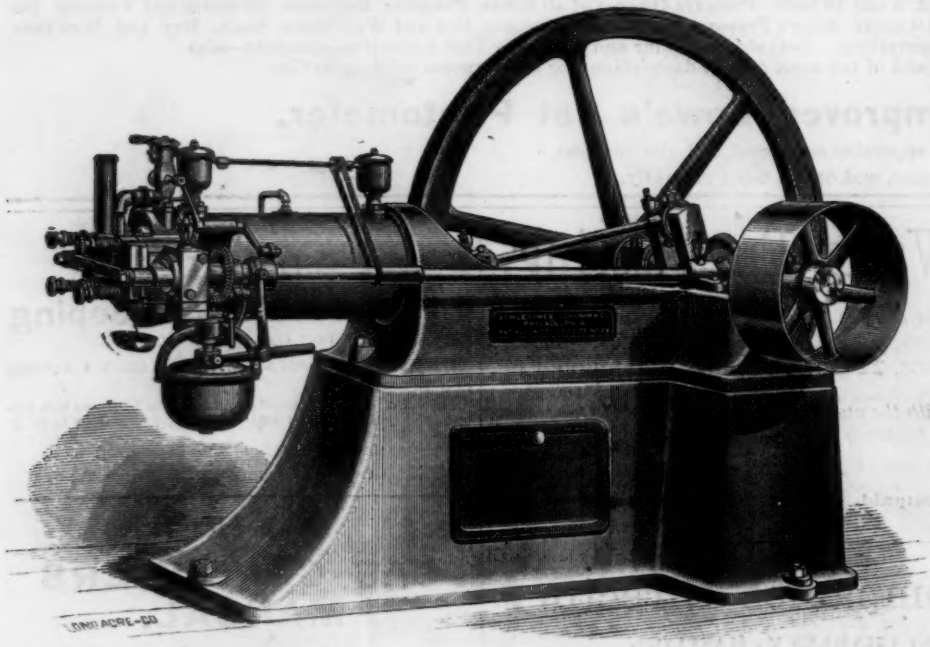

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